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FOR BOOKS ON RAILROADS







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AN
HISTORICAL, STATISTICAL, AND SCIENTIFIC
ACCOUNT
OF
THE RAILWAYS OF BELGIUM
FROM 1834 TO 1842.

TRANSLATED AND COMPILED FROM OFFICIAL DOCUMENTS

BY

EDWARD DOBSON, Assoc. I.C.E.

With Three Plates.

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P R E F A C E.

THE interest of its subject, and the difficulty of obtaining accurate information respecting foreign engineering works during their execution, sufficiently explain my reasons for bringing the present work before the Public.

The railways of Belgium, from the peculiar circumstances under which they have been constructed, demand the especial attention of the engineers of this country, where the whole of the existing lines have been executed by private enterprise, at a cost from double to treble that of the Belgian railways; and the proposed establishment of a system of Government railways for Ireland gives an additional interest to the subject at the present moment.

The following account of the railways of Belgium has been compiled from the reports and official returns presented at different times to the legislative chambers, and from personal observations made during a recent visit to that country in the autumn of the present year.

The descriptions of the machinery for working the Liège inclines, and of the Val-Benoît bridge, are drawn up from the contract specifications.

The detailed account of the works on the several lines is translated, with slight alteration, from the last report of the minister of public works, those parts being of course omitted which are only of local or temporary interest.

The returns relative to the cost of establishment, amount of traffic, working expenses, &c., are also taken from this and preceding reports.

I have not thought it worth while to swell these pages by giving a description of the private lines of railway, as they are at present almost exclusively confined to the colliery districts, and are of but little importance in an engineering point of view.

In the numerous calculations made for reducing the foreign to the English measures, I can scarcely venture to hope that no errors have escaped detection, but I trust they are very few in number and unimportant in their nature.

EDWARD DOBSON.

London, December, 1842.

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INTRODUCTION.

THE northern and southern provinces of Belgium present features of a very opposite character.

The provinces of Antwerp, Eastern Flanders, and Western Flanders, are a series of rich polders, intersected by numerous canals and dykes, and so teeming with population that this part of Belgium has been compared to an immense village, to which the numerous hamlets and châteaux give it no small resemblance.

The provinces of Hainault, Namur, Liège, and Luxembourg, on the contrary, have a very different character, consisting principally of a rugged district of mountains covered with dense forests still harbouring the bear and the wolf, intersected by rapid streams, and scantily peopled by a hardy race, different in both character and language from the inhabitants of the Flemish provinces.

It will be seen, from the above remarks, how varied are the conditions under which the railway system of Belgium has been established. The northern and western lines, placed but a few feet above the level of the sea, with gentle curves and almost on a dead level, presented few engineering difficulties, the principal point of importance being to avoid interference with the drainage

of the districts through which the lines pass; whilst the eastern and southern lines, carried across mountain ridges upwards of eight hundred feet above the level of the sea, and through valleys in one instance four hundred feet in depth, have required works of art which, from their magnitude and the difficulty of their execution, will bear comparison with any of those of the present day.

By reference to the map of Belgium it will be seen that the great central line from Ostend to Liège crosses nearly all the principal valleys at right angles, presenting in the hilly districts a rapid succession of heavy cutting and embankment, whilst the eastern and southern lines, viz., from Ghent to Tournay, Brussels to Quiévrain, Braine-le-Comte to Namur and Liège, and from the latter place to the Prussian frontier, have been laid out for the greater part of their several lengths, along the sides of, or parallel to, the valleys watered respectively by the Rivers Lys, Senne, Sambre, Meuse, and Vesdre; and from the numerous works of art required for the crossings of the several rivers and the lateral valleys, as well as for maintaining uninterrupted the existing communications with the numerous manufacturing establishments on the banks of the Meuse and Sambre, are of a much more expensive character than the former.

Amongst the various works of art, the beautiful bridge of the Val-Benoît over the Meuse above Liège deserves especial notice, both from the elegance of the design and the excellence of its execution. The pile foundations used in the erection of this bridge, and in similar situations, are worthy of mention as a remarkably economical

mode of obtaining a foundation, without having recourse to the expensive methods in common use.

In the erection of the viaduct which carries the railway across the lowest part of the marshes between Templeuve and Tournay (western line), the engineers had recourse to the American system of driving piles through the marsh until they reached the firm ground, at an average depth of 22 ft. below the surface; on the heads of these piles were laid timber platforms, as in the erection of the Val-Benoît bridge, on which the piers of the arches were built in the usual manner.

The planting of the slopes is a feature which deserves attention, whether viewed as a protection against slips, or as a source of future revenue, to say nothing of the pleasing effect to the eye of the traveller, as contrasted with the naked and dismal appearance of some of the deep cuttings on the English railways.

The self-creating nature of railway traffic has, perhaps, never been so fully displayed as on the Belgian railways. Let us take as an example the line from Brussels to Mechlin. A short time before the revolution, the Dutch Government caused returns to be made of the number of passengers carried annually by the public conveyances between the towns of Brussels, Mechlin, Liége, and Antwerp. These returns showed the average number of passengers conveyed annually between Brussels and Mechlin to be about 75,000, and it was calculated that this would be about three-fourths of the number of passengers who would avail themselves of the railway. But at the close of the year 1836, after the rail-

way had been open eight months, it was found that the number of passengers carried between these towns amounted to no less than 421,439, or upwards of eight times the number conveyed in the same number of months previous to the establishment of the railway.

The number of persons conveyed on the railways from the 1st of May, 1835, up to the 31st of December, 1841, amounts to upwards of eleven millions.

The carriage of goods was not commenced until 1838. The directors, in the first instance, confined themselves to letting out empty waggons to the common carriers and forwarding them by the trains. This arrangement remained in force till August, 1840, when the directors determined on becoming their own carriers, charging according to tonnage, on a scale varying with the nature of the merchandize to be transported. In May, 1841, this system was further extended by the delivery of goods at their place of destination, instead of merely transporting them from station to station, thus completely destroying the business of the private carriers, who, finding their occupation taken from them, commenced an organized opposition, which, if it was not productive of benefit to themselves, materially injured the traffic on the railways.

In a report dated the 22nd March of the present year (1842), the minister of public works estimated the loss arising from the adoption of the systems of 1840 and 1841 to be not less than £25,618. 10s. 5d. for the seventeen months during which they had been in operation, and recommended a return to the original system.

In accordance with this suggestion, the letting out of waggons to the carriers was recommenced in the following May, and has continued ever since ; the management still, however, undertaking the carriage and delivery of goods as before.

The total receipts from the carriage of merchandize for 1838 amounted to £2343. 15*s.* 7*d.*, and for 1841 to £79,395. 9*s.* 4*d.* The regular progression of the traffic, month by month, during 1839, is very remarkable ; the receipts for February under this head amounting to £286. 7*s.* 7*d.*, and for October to £2991. 12*s.* 7*d.*, showing a tenfold increase during eight months only.

In the face of this extraordinary traffic, that on the common roads has progressively increased,—a fact which illustrates most forcibly the benefit which has resulted to the commercial interests of the country from the increased facility of communication afforded by the establishment of the railways. The following Table of the produce of the péage des barrières, answering to the English turnpike tolls, from 1831 to 1839, may be interesting.

The produce of the tolls let to the highest bidder was, in

	Francs.	
1831	2,390,882	
1832	2,195,343	
1833	2,360,416	
1834	2,415,769	
1835	2,385,430	year of the first opening of the railways.
1836	2,447,985	
1837	2,584,791	
1838	2,759,548	
1839	2,749,301	

Perhaps the most striking feature of the railway system of Belgium is the extension of the benefit of rapid communication to the humblest equally with the highest ranks of society.

It will be seen by reference to the returns that the amount received from waggon passengers is greater than that derived from those either of the first or second classes; and no one who has not travelled on the Belgian lines can form an idea of the extent to which the peasantry avail themselves of the facilities of transit afforded by the railways. The very poorest are hardly so poor but that the saving of time counterbalances the expense of railway conveyance: let us illustrate this by a practical example. An agricultural labourer will earn about 15*d.* per diem, so that the value of his time may be considered to be about $1\frac{1}{4}$ *d.* per hour: if he has to travel a distance of three miles, this journey, if undertaken on foot, will not occupy less than an hour, which will occasion a loss of $1\frac{1}{4}$ *d.*; the fare on the railway will be $1\frac{1}{2}$ *d.*, and the journey will not occupy more than twelve minutes, making a total loss of $1\frac{3}{4}$ *d.*, whilst the time saved is equivalent to 1*d.*, so that a saving of $\frac{1}{4}$ *d.* is effected by the use of the railway.

The question here naturally arises, Will the working of the Belgian railways pay the interest of the capital expended on their construction? By reference to the returns given in Chap. III., it will be seen that the net revenue for 1842 is estimated at $4\frac{1}{2}$ per cent. on the capital engaged in the construction of the lines from the working of which this profit is to be derived. We

may assume the *average* cost per mile of the lines at present open to be about £12,000; their *actual* cost ranging from about £8000 to £16,000 per mile. It is therefore evident that whilst some lines are yielding a large profit, others are hardly paying their working expenses; a conclusion which is confirmed by the fact that the net receipts of 1841 were less than those of 1840 by upwards of £5000, whilst the number of miles run by trains was considerably greater. The following is a comparison of the working of these two years:

Excess of receipts over expenditure.				Number of miles run by trains.	Net receipts per mile per train.	
£.	s.	d.			s.	d.
1840,	83,226	4	8½	733,879	2	3
1841,	78,133	6	11½	900,106	1	8½

Although, from the progressive increase of the traffic since the first opening of the railways, there appears little reason to doubt that the net receipts will ultimately cover the interest of the six millions of capital to be sunk in the undertaking, it seems very questionable whether some of the lines will not always be worked at a loss; for example, the line from Liège to the Prussian frontier, which will have cost by the time it is completed little less than £50,000 per mile, not including the furnishing of the line, can hardly be expected even by the most sanguine to realize, under the present tariff, more than 1½ or 2 per cent. on the capital; whilst it is as yet doubtful whether the steepness of the gradients will

not even cause the working expenses to exceed the receipts.

The result of our inquiry, therefore, amounts to this,—that although taken as a whole the traffic on the several lines will probably fully cover the interest of the capital, the net revenue will be much less than it would have been, had the Government confined itself to the construction of some particular lines. Whence we may conclude, that had the construction of the railways been left to private enterprise, either one-half of the present lines would have remained unexecuted, or an increased tariff would have neutralized the benefits which Belgium is now reaping from increased facilities of communication.

We cannot better conclude these introductory remarks than by quoting the following observation made by a French writer on this subject:—"L'expérience ayant démontré partout que les grandes entreprises de ce genre ne sont jamais concédées à des sociétés particulières, qu'au préjudice du public, en absorbant à perpétuité, ou pendant de longues années, des bénéfices auxquels un gouvernement ne peut prétendre pour son compte, il eût été à regretter que l'intérêt de quelques capitalistes l'emportât sur celui de la masse, et qu'un tarif, peut-être double ou triple vînt paralyser ou restreindre les heureux effets du chemin de fer pour un pays qui a commencé et qui poursuit son œuvre avec tant de courage et de persévérance."

THE RAILWAYS OF BELGIUM.

CHAPTER I.

CONSTRUCTION.

SECT. I.—*General Description of the Belgian Railways.*

General Direction.—The laws of the 1st of May, 1834, and of the 26th of May, 1837, authorized the construction, at the expense of the State, of four great lines of railway, which should diverge from Mechlin, as a common centre, in the following directions :

	miles.	chains.
Northward to Antwerp, for a length of . . .	15	67
Eastward to the Prussian frontier at Welkenraedt, with a branch from Landen to St. Trond . . .	91	52
Westward to Ostend, with a branch from Ghent to the French frontier and Tournay . . .	125	66
Southward to the French frontier at Quiévrain, with a branch from Braine-le-Comte to Namur . . .	115	46
Total length . . .	348	71

In the official returns published by the Belgian Government, however, Brussels is taken instead of Mechlin as the point of division between the north and south lines; and as this arrangement is much more simple and convenient than the former, we shall adhere to it throughout the present work.

Taking, then, Brussels as the starting point for the northern and southern, and Mechlin as that for the eastern and western, lines, the routes and lengths of the several lines are as follows :

	miles.	chains.
<i>North Line</i> , to Mechlin and Antwerp, in length .	28	71
<i>East Line</i> (with a branch line from Landen to St. Trond), to Louvain, Tirlemont, Landen, Warremme, Liège, Chênée, Chaudfontaine, Pepinster, Verviers and Dolhain-Limbourg, to unite at Welkenraedt (on the Prussian frontier) with the Rhenish railway running from the Belgian frontier to Aix-la-Chapelle and Cologne, whence it is proposed to unite it by way of Minden (for which the surveys are in a forward state) with the numerous German railways which will soon be opened between Berlin and Vienna, thus uniting the North Sea at once with the Danube and the Baltic	91	52
<i>West Line</i> , to Ostend by Termonde, Ghent, and Bruges, with a branch line from Ghent towards the French frontier at Mouscron by Deynze-Peteghem and Courtray, (to unite at Courtray with the French railway to Lille and Paris,) and from Mouscron to Tournay	125	66
<i>South Line</i> , to Hal, Braine-le-Comte, Soignies, and Mons, to join at Quiévrain the French railway from Paris to Valenciennes and the Belgian frontier (with a branch from Braine-le-Comte to Charleroy and Namur)	102	42
N.B. The branch railway uniting the Brussels north and south stations is considered to form part of the south line.		
Total length as before	348	71

Gradients, Curves, &c.—The gradients on the lines at present opened are very favourable, the steepest not exceeding 1 in 200, with the exception of the Liège inclines of 1 in 36, worked by fixed engines, and an incline of 1 in 70 at Louvain, on the branch line leading from the railway station to the canal basins, which is not travelled over by trains. The unopened portion of the eastern line, however, presents much more formidable gradients, the most objectionable of which are a short incline of 1 in 111, near Dolhain-Limbourg, and an incline of 1 in 125, $2\frac{1}{2}$ miles in length, between Dolhain and the Prussian frontier.

The curves are generally favourable; the most objectionable are—

Two of 19·88 chains radius, between Brussels and Mechlin.

One of 9·44 ,, on the branch line leading to the canal basins at Louvain.

One of 19·88 ,, between Mechlin and Termonde.

One of 18·13 ,, Ghent and Bruges.

One of 9·94 ,, Bruges and Ostend.

One of 17·39 ,, " "

One of 19·88 ,, " "

One of 18·13 ,, Ghent and Deynze.

Gauge of Way, &c.—The clear gauge of the lines throughout is 4 ft. $8\frac{1}{2}$ in.,¹ and the intermediate space 6 ft. $6\frac{3}{4}$ in.

The rails in present use are wrought iron parallel T rails in lengths of 14 ft. 9 in., and weigh 50 lbs. to the lineal yard; they are fixed with iron wedges in cast iron chairs placed 3 ft. 3 in. apart from centre to centre.

¹ 1 mètre 50 c. from centre to centre of rails.

The joint chairs weigh 24 lbs. and the intermediate ones 21 lbs. each.

The way is laid throughout on cross sleepers.

The rails at first laid down were of the fish-bellied form, and weighed only 40 lbs. per lineal yard. The joint and intermediate chairs used with this description of rail weigh respectively 20 lbs. and 16 lbs. Nearly all these rails have been taken up and exchanged for the 50 lbs. rails now in use.

The following descriptions of ballasting have been used in different parts of the railways, viz., gravel, sand, broken stone, small coal, dross from founderies, and cinders. In some of the stations, where small coal is used for this purpose, the tracks are distinguished by a layer of sand or gravel.² The slopes of the embankments and cuttings are grassed over and planted with trees, and are in some instances protected at bottom by dwarf retaining walls of rubble masonry.

Near Tirlemont, and on many parts of the railways, a system of benching has been resorted to in the cuttings with great success.

The system of drainage throughout the whole of the railway appears to be very complete.

In the cuttings the surface water is brought down the face of the slopes by wooden troughs or semicircular half brick drains, into the horizontal side drains, which are paved at bottom, and are of ample section to carry off the water.

² This simple expedient is found to be of great service in keeping the way clear for the passage of the engines, especially on holidays when the concourse of passengers is very great.

The barriers at the level crossings consist merely of a sliding horizontal bar resting in two upright posts.

The railways are not fenced off from the adjoining land except in the immediate vicinity of the stations.

The distance standards are of wood, and are placed at intervals of 24·85 chains. The whole of the distances are measured from a stone column erected for that purpose in the centre of the Mechlin station.

Arrangement of the Stations.—The arrangement of the stations is simple and inexpensive, the only buildings erected being those actually required for the service of the traffic.

The booking offices and passengers' waiting rooms usually form a long one-story building, one room deep, with doors in front and rear, communicating with the exterior and interior of the station.

The booking offices are placed in the centre and the waiting rooms at the ends of the building, by which arrangement the third-class or waggon passengers are kept entirely distinct from those making use of the first and second-class carriages. The fares are taken and the tickets given at pigeon holes in the fronts of the booking offices, which command in the rear an almost uninterrupted view of the interior of the station through large windows, or, more properly speaking, glazed partitions.

The waiting rooms are of large dimensions, but are not fitted up with the comforts and conveniences which form so prominent a feature in the arrangement of the passenger stations on the English railways.

It should be, however, borne in mind, that many of these buildings are merely temporary erections, which are being replaced at the first-class stations by substantial two-story buildings, which, although built in a plain and inexpensive manner, have a neat and pleasing appearance, combined with much architectural effect. One of the handsomest of these new stations (which are, however, all built to one uniform design, slightly modified according to circumstances) has been lately completed at Louvain; others are erecting at Bruges, Tirlemont, &c.

There are no passenger sheds or platforms as in England, and the booking offices are generally a considerable distance from the rails.

The conveniences form detached erections and are well contrived, but are in very exposed situations.

The engine-houses are brick buildings, rectangular on plan, and of a plain but architectural elevation.

The turn-tables for locomotives are 13 ft., and those for carriages 10 ft., in diameter. The switches are worked in some places by eccentrics, and in others by lever handles, weighted to keep the points right for the main line.

The central dépôt is at Mechlin, and contains extensive workshops for the repairs of the locomotives and tenders, and for the construction and repair of the carriages, trucks, and waggons, required for the service of the line.

The buildings for the stationary engines on the Liège inclined planes are constructed of brick in the most substantial manner, and have a bold and architectural appearance.

The buildings at the intermediate stations only require notice on account of their simple and inexpensive character, no outlay having been made on them beyond what was absolutely necessary to carry on the traffic.

Connected with the subject of stations may be mentioned the huts erected at intervals on the side of the railway for the police of the road and for the tools and stores of the waymen. Close to each of these is placed a cast iron stand supporting a stock of spare rails, with the proper complement of chairs and sleepers, ready for immediate use.

SECT. II.—*Detailed account of the works of the Belgian Railways.*

Sections opened for traffic up to the 1st of January, 1842.

NORTHERN LINE.

SECTION FROM BRUSSELS TO MECHLIN.

The first line of way was opened between Brussels and Mechlin on the 6th of May, 1835.

The section is 12 miles 34 chains in length.

The principal gradients are—

Beyond Vilvorde, one of 1 in 357, for the length of 41·75 chains.
And near Mechlin, „ 1 in 400 „ 48·71 „

The principal curves are—		Radius.	Length.
		chains.	chains.
At the entrance of the station at Mechlin .	.	19·88	17·39
Near the bridge of Eppeghem	.	19·88	68·14
Curve and counter curve at the Vilvorde station	.	49·70	30·07
Between the distance posts, 4½ and 5½ . .	.	99·40	30·81

The principal works of art are—

At Laeken, a bridge over the Senne of one elliptic arch, 39 ft. 4½ in. span.

At Eppeghem, a culvert or viaduct of fourteen elliptic arches, each 6 ft. 6¾ in. span.

At the same place, a bridge over the Senne of two segmental arches, each 20 ft. 6 in. span.

At Sempst, a bridge over the Senne similar to that at Eppeghem. And, lastly, at the entrance of the station at Mechlin, an iron turn-bridge over the Louvain Canal, 27 ft. 10½ in. span.³

The laying down of the second line of way was begun in 1837, but it was not opened until the beginning of 1838.

The section has received two junctions, viz.:

1. The branch line leading to the Brussels northern station, which is about 74·55 chains in length, and was laid in the first instance with a double line of way. It was formally opened at the fêtes of September, 1841, and has been worked ever since.

2. The branch line uniting the northern and southern lines. This branch crosses the Willebrouck Canal by a bridge belonging to the town of Brussels, and skirts the Boulevards. It has only a single line of way, and is about 129·22 chains in length. The opening⁴ and inauguration took place at the fêtes of September, 1841.

The section from Brussels to Mechlin has been the subject of a very heavy expenditure since its opening, from the three following causes:

³ A second bridge, similar to the first, is being built at the entrance of the Mechlin station.

1. The formation of the way at too depressed a level.
2. The use of white and other fir timber for the sleepers.
3. The lightness of the rails.

The effect of the first of these causes has been that the slopes of the road have been injured at every overflow of the Senne; that the floods have several times risen so much above the level of the road as to interrupt the traffic;⁴ and, lastly, that the drainage of the valley of the Senne during the periodical inundations has been materially affected.

Different works have been undertaken, and are still in process of execution, to remedy these evils; the slopes have been protected by retaining walls of rubble-work and by hurdles; the level of the rails has been raised on an average 1 ft. 7½ in., and additional ballasting has been put on the road for the distance of about 298·20 chains; lastly, the Eppeghem viaduct, and several culverts, have been constructed, to regulate and facilitate the escape of the flood-water. The sums already expended on these heads amount to about £ 6,800.

The employment of white fir sleepers makes it necessary to replace almost all those which have not already been changed since they were first laid down.

The present price of pollard oak sleepers delivered is 3s. ¼d., whilst those of white fir cost from 2s. 5d. to 3s. 1¼d.

⁴ In the spring of 1839 the floods rose 6 inches above the level of the rails, and all communication between Brussels and Vilvorde was suspended for a time.

Nothing has been neglected to diminish as much as possible the expense of renewing the sleepers. Experiments are now being tried to test the merit of M. Boucherie's process of preserving wood from decay, by means of a preparation of pyrolignite of iron, sea salt, and sulphate of soda.

This process is inexpensive, and has already in France been subjected to trials which appear to have been generally satisfactory. It will be impossible to know before next year the result of the experiments now in progress.

Lastly, the lightness of the rails has caused such an amount of waste and breakage, that during the year 1841 it was necessary to replace 2000 rails, and the renewal of the old rails must be continued during the present year (1842) on a still more extensive scale. The minimum cost of changing the rails cannot be estimated at less than that of laying them down in the first instance.

SECTION FROM MECHLIN TO ANTWERP.

This section was opened for traffic in the month of May, 1836; its length is about 14 miles 60 chains.

The principal gradients are, going from Mechlin,

Between Contich and Hove, an		chains.
inclination of	1 in 500 for the length of 45·43	
From Hove to beyond Vieux-		
Dieu, an inclination of	1 in 500	„ 140·45
Lastly, nearer Antwerp, an in-		
clination of	1 in 370	„ 107·85

The curves are—

	Radius. chains.	Length. chains.
At the Surinckx Hof (in the commune of Mechlin)	149·10	19·23
Near the bridge of Duffel	69·58	23·96
At the distance post, 31½	139·16	17·05
„ „ 38½	198·80	34·09
At the entrance of the Antwerp station . .	59·64	34·79

The principal works of art are—

A bridge over the Dyle, close to the Mechlin station. This bridge has two elliptic arches, each 49 ft. 2½ inches span.

A bridge of one semicircular arch, 21 ft. 3¾ in. span, between the distance standards Nos. 21 and 21½.

A bridge of 36 ft. 1 inch span, over the Waes Bliet. This bridge is of masonry, and has one elliptic arch.

A bridge over the Grande Nèthe, near Duffel, formed of five elliptic arches, each 19 ft. 8¼ in. span, and an opening 22 ft. 11½ in. wide, over which is placed a cast iron turn-bridge. There is also an opening in the pier supporting the pivot of the turn-bridge.

Lastly, a bridge 16 ft. 4¾ in. span, over the Herenthals Canal, near Antwerp.

The second line of way has been open ever since the month of June, 1837.

The inundations have never caused any accidents upon this section. The only expenditure found requisite has been caused by the necessity of changing the white fir sleepers at first employed, as well as the light rails made use of in the original construction of the railway.

The formal opening of the commercial station of the railway on the right bank of the Scheldt took place on the 25th of August, 1840.

EASTERN LINE.

SECTION FROM MECHLIN TO LOUVAIN.

This section was opened for traffic on the 10th of September, 1837.

The works of art, and the earth-works for a double line of way, were contracted for on the 3rd of March, 1836. The length of the section is 14 miles 72 chains.

The works of the second line of way, from Mechlin to Haecht, were commenced on the 11th of June, 1839, and from Haecht to Louvain on the 1st of January, 1841.

The second line of way was opened from Mechlin to Haecht on the 15th of October, 1839, and from Haecht to Louvain on the 4th of October, 1841.

This section comprises six inclines (*rampes*), of a total length of 10 miles 20 chains, of 1 in 1000, 1 in 500, 1 in 333, and 1 in 239; six slopes (*pentes*), of a total length of 4 miles 3 chains, varying from 1 in 1000 to 1 in 500; and seven curves, viz.:

A curve of 24·85 chains radius, and 21·17 chains in length.

Do.	74·55	„	52·68	„
Do.	149·10	„	86·47	„
Do.	173·95	„	30·56	„
Two do.	248·50	„	31·31	„
Do.	298·20	„	76·67	„

The principal works of art are—

Five bridges, of which four are from 13 ft. 1½ in. to 16 ft. 4¾ in. span, and one of 39 ft. 4½ in. span.

A tunnel 121 ft. 4 in. long, and 22 ft. 11½ in. wide.

Four bridges over ordinary roads, from 9 ft. 11 in. to 16 ft. 4¾ in. span.

Thirty-four culverts, of 1 ft. 11½ in., 2 ft. 7½ in., 3 ft. 3½ in., 4 ft. 11 in., 6 ft. 6¾ in., and 10 ft. 2½ in. opening; and

Thirty crossings of paved and common roads, with barriers.

To guard against inundations, a bridge 16 ft. 4¾ in. span has been built at Muyse. This bridge was constructed to allow the diversion of a portion of the waters of the basin of the Senne into that of the Dyle.

The earth-works on this section are trifling.

SECTION FROM LOUVAIN TO TIRLEMONT.

The section from Louvain to Tirlemont was opened for traffic on the 28th of September, 1837. Its execution lasted three years; its length is 12 miles 9 chains.

The works of art, and the earth-works for a double line of way, were contracted for on the 17th of September, 1834.

The works of the second line of way were begun between Louvain and Vertryck on the 1st of February, 1840, and between Vertryck and Tirlemont the 7th of January, 1841.

The second line of way, executed at different times, was opened for traffic on the 25th of April, 1841.

This section comprises—

Four inclines (*rampes*), of a total length of 430·84 chains, from 1 in 1000 to 1 in 250.

Five slopes (*pentés*), measuring together 524·17 chains, from 1 in 1000 to 1 in 500.

And twelve curves, viz.:

A curve 49·70 chains radius, and 21·05 chains in length.

Do.	62·12	„	38·11	„
Do.	67·09	„	64·70	„
Do.	74·55	„	63·80	„
Do.	86·97	„	20·02	„
Do.	86·97	„	47·25	„
Do.	89·46	„	59·98	„
Do.	99·40	„	40·79	„
Three do.	124·25	„	41·25	„
			35·52	„
			48·24	„
Do.	198·80	„	73·99	„

The principal works of art are—

The single line tunnel of Comptich, 45·72 chains in length, cut through very difficult ground.

(The works for a second tunnel have been lately commenced.)

A bridge over the Velp, 16 ft. 4¾ in. span.

A road-bridge over the railway, 22 ft. 11½ in. span.

Ten bridges over ordinary roads, from 6 ft. 6¾ in. to 18 ft. span.

Thirty culverts, from 1 ft. 7½ in., 2 ft. 7 in., 3 ft. 3½ in., and 4 ft. 11 in. to 8 ft. 2 in. wide.

Twenty-three crossings of paved and common roads, with double barriers.

The earth-works are of considerable magnitude.

SECTION FROM TIRLEMONT TO WAREMME.

The section from Tirlemont to Waremmé was opened for traffic on the 2nd of April, 1838; its length is 14 miles 39 chains.

The works of art, and the earth-works for a double line of way, were contracted for on the 19th of April, 1835.

The works of the second line of way were commenced between Tirlemont and Landen on the 10th of February, 1840; and between Landen and Waremmé the 1st of May, 1841.

This section comprises—

Nine inclines (*rampes*), of a total length of 931·17 chains, from 1 in 1000 to 1 in 250.

Three slopes (*pentés*), of 114·31 chains, from 1 in 1000 to 1 in 500.

Eight curves, viz.:

A curve of 94·43 chains radius, and 81·30 chains in length.

Do.	96·91	„	78·56	„
Do.	99·40	„	101·18	„
Do.	119·28	„	52·52	„
Do.	126·73	„	95·81	„
Do.	126·73	„	97·45	„
Do.	198·80	„	45·56	„
Do.	248·50	„	51·03	„

The principal works of art are—

A bridge 26 ft. 3 in. span.

A culvert 13 ft. 1½ in. wide.

Six road bridges over the line, all of 24 ft. 3 in. span.

Twelve bridges over ordinary roads, from 11 ft. 6½ in. to 14 ft. 9 in. span.

Forty culverts, from 1 ft. 7½ in., 3 ft. 3 in., and 4 ft. 11 in. to 8 ft. 2¼ in. wide.

And fifty crossings of paved and common roads, with double barriers.

The earth-works on this section are very heavy.

SECTION FROM WAREMME TO ANS.

The section from Waremmé to Ans was opened for traffic on the 2nd of April, 1838; its length is 12 miles 17 chains.

The works of art, and the earth-works for a double line of way, were contracted for on the 13th of April, 1836.

A portion of the second line (124·25 chains), beyond Fexhe, was executed in great haste in November, 1840. The remainder of the section was commenced on the 19th of March, 1841.

A portion near Fexhe was opened for traffic in February, 1841, and the remainder on the 21st of October of the same year.

This section comprises—

Ten inclines (*rampes*), of a total length of 729·93 chains, of from 1 in 500 to 1 in 250.

A slope (*pente*), of 49·70 chains in length, of from 1 in 1000 to 1 in 500.

Three curves, viz.:

A curve of 114·31 chains radius, and 49·84 chains in length.

Do.	335·47	„	122·50	„
Do.	447·30	„	59·64	„

The principal works of art are—

Two road-bridges over the line, each of 24 ft. 3 in. span.

Eleven bridges over ordinary roads, from 11 ft. 6½ in. to 14 ft. 9 in. span.

Thirty-five culverts, 1 ft. 7½ in., 2 ft. 7½ in., and 3 ft. 3½ in. wide.

And forty-nine crossings of paved and common roads, with double barriers.

The earth-works are also very heavy on this section.

SECTION FROM LANDEN TO ST. TROND.

The section from Landen to St. Trond was opened for traffic on the 6th of October, 1839; its length is 6 miles 62 chains; it is a single line.

The works were contracted for on the 20th of June, 1838.

This section comprises—

Two culverts, 6 ft. 6½ in. and 9 ft. 11 in. wide.

Two do., 1 ft. 7½ in. and 2 ft. 7½ in. wide.

Five bridges over ordinary roads, 13 ft. 1½ in. span.

Eleven crossings of paved and common roads, with double barriers.

An incline (*rampe*), of 11·92 chains in length, of from 1 in 1000 to 1 in 250.

Three slopes (*pentes*), of 437·36 chains in total length, of from 1 in 1000 to 1 in 250.

LOUVAIN BRANCH—FROM THE STATION TO THE CANAL BASINS.

This branch was opened for traffic in June, 1841; it is a single line, 46·71 chains in length.

The works were contracted for on the 20th of November, 1839.

This branch comprises—

A bridge, 39 ft. 11½ in. span.

Do. 19 ft. 0¼ „

A culvert, 2 ft. 7½ in. wide.

An incline (*rampe*), of 1 in 71,—29·82 chains in length; and 4 curves, viz.:

One of 9·44 chains radius, and 9·44 chains in length.

„	12·42	„	7·95	„
„	29·82	„	8·94	„
„	54·67	„	4·97	„

WESTERN LINE.

SECTION FROM MECHLIN TO TERMONDE.

The section from Mechlin to Termonde was opened for traffic on the 2nd of January, 1837. The time occupied in the execution of the works was 16 months.

The line is a double one, of the length of 16 miles 37 chains.

The sidings comprise altogether a length of 447·04 chains.

The principal slopes (*pentes*) are—

One of 55·55 chains in length, of 1 in 3333

Do.	104·16	„	1 in 1250
Do.	506·58	„	1 in 833
Do.	383·82	„	1 in 500
Do.	10·87	„	1 in 192
Do.	9·13	„	1 in 125

The principal curves are—

One of 19·88 chains radius.

Do.	263·41	„
Do.	176·43	„
Two of	99·40	„
Do.	248·50	„
One of	173·95	„
Do.	99·40	„

The principal works of art are—

A bridge of two arches over the Senne at Hombeeck.

An iron turn-bridge at Capelle over the Willebroeck Canal.

A large viaduct over the railway at Malderen.

Two bridges over ordinary roads.

Ninety-one culverts.

The buildings of the Termonde station.

Fifty-four crossings of common and highroads.

The works of the second line were begun—

From Mechlin to Capelle, on the 1st of May, 1839.

„ Termonde to Buggenhout, „ „

„ Buggenhout to Malderen, on the 5th of September, 1840.

„ Malderen to Capelle, on the 10th of January, 1841.

The second line was opened for traffic—

Between Mechlin and Capelle, on the 9th of September, 1839.

„ Termonde and Buggenhout, on the 28th of April, 1840.

„ Buggenhout and Malderen, on the 1st of November, 1840.

„ Malderen and Capelle, on the 31st of October, 1841.

Several works have been executed to regulate and facilitate the escape of the waters at times of inundations, viz. :

A culvert 4 ft. 11 in. wide at Londerzeel.

Do. 6 ft. 6½ in. „ „

A small road-bridge 5 ft. 10½ in. span at Malderen.

A culvert 3 ft. 11 in. wide at Buggenhout.

Do. 3 ft. 3 in. „ „

SECTION FROM TERMONDE TO GHENT.

The section from Termonde to Ghent was opened for traffic on the 28th of September, 1837.

The execution of the works occupied a year and five months.

It is a double line, 18 miles 26 chains in length.

The sidings comprise altogether a length of 169·27 chains.

The principal slopes (*pentes*) are—

One of 108·94 chains in length, of 1 in 2500			
Do.	276·82	”	1 in 1000
Do.	515·97	”	1 in 666
Do.	271·85	”	1 in 500
Do.	27·83	”	1 in 346

The principal curves are—

One of 99·40 chains radius.			
Do.	186·37	”	
Do.	261·01	”	
Do.	134·19	”	
Do.	49·70	”	

The principal works of art are—

An iron turn-bridge over the Dendre at Audeghem.

Four bridges over ordinary roads.

A bridge over the railway at Wetteren.

A bridge-keeper's house.

Six large culverts.

Fifty-eight small do.

A retaining wall at Ledebergh.

The buildings and appendages of the Ghent station.

Forty crossings of roads and highways, with barriers.

The works of the second line were commenced—

Between Wetteren and Ghent, on the 1st of May, 1839.

„ Termonde and Audeghem, „ „
 „ Audeghem and Wetteren, on the 1st of January, 1840.

The second line was opened for traffic—

Between Wetteren and Ghent, on the 29th of April, 1840.

„ Termonde and Audeghem, „ „
 „ Audeghem and Wetteren, on the 21st of October, 1841.

The floods have never caused any damage on this section.

SECTION FROM GHENT TO BRUGES.

The section from Ghent to Bruges was opened for traffic on the 12th of August, 1838.

The execution of the works occupied a year and nine months.

The line is a single one, 27 miles 58 chains in length.

The sidings comprise altogether a length of 77·22 chains.

The principal slopes (*pentes*) are—

One of 254·00 chains in length, of 1 in 1666		
Do.	180·05	„ 1 in 1000
Do.	603·20	„ 1 in 666
Do.	386·66	„ 1 in 500
Do.	38·65	„ 1 in 400
Do.	26·34	„ 1 in 277

The principal curves are—

One of 18·13 chains radius (on an incline of 1 in 277).

Do. 37·27 „
 Two of 298·20 „

The principal works of art are—

One large bridge of three arches over the Scheldt, close to the Ghent station.

Five bridges over different rivers.

An iron turn-bridge over the Lys at Tronchiennes.

A bridge-keeper's house.

A road-bridge over the railway at Aeltre.

A bridge over an ordinary road at the same place.

Sixty-six culverts.

The buildings of the Aeltre station.

To guard against the damage caused by the overflowing of the Lys to the slopes in the meadows of Tronchiennes, they have been strengthened with hurdle-work, and numerous oak drain-pipes have been laid down.

The earth-works are unimportant upon this section.

SECTION FROM BRUGES TO OSTEND.

The section from Bruges to Ostend was opened for traffic on the 28th of August, 1838.

The execution of the works occupied a year and three months.

The line is a single one, in length 13 miles 53 chains.

The sidings comprise altogether a length of 25·04 chains.

The principal slopes (*pentes*) are—

One of	79·02 chains in length,	of 1 in 2500
Do.	5·11	„ 1 in 1666
Do.	240·98	„ 1 in 1000
Do.	137·06	„ 1 in 666

The principal curves are—

One of 39·76 chains radius.

Do. 44·73 „

Do. 331·49 „

Do. 17·39 „

Do. 19·88 „

Do. 43·73 „

Do. 9·94 „

The principal works of art are—

The buildings and minor works of the Bruges station.

Two bridges over ordinary roads in crossing the town of Bruges.

An iron turn-bridge over the Nieuport Canal at Plasschendale.

A bridge-keeper's house.

Thirty-four works of art executed between the old and the new stations, consisting of bridges, sluices, and culverts.

The buildings of the old station.

The coke ovens and the buildings of the new station.

Thirty-one crossings of highways and roads, with double barriers.

In crossing the fortifications of Ostend, and at the bridge of Plasschendale, the slopes are protected by brick revêtements.

The earth-works are very trifling.

SECTION FROM GHENT TO DEYNZE.

The section from Ghent to Deynze was opened for traffic on the 22nd of September, 1839.

The line is a single one, of the length of 10 miles 64 chains.

The sidings comprise altogether a length of 146·30 chains.

The principal slopes (*pentes*) are—

One of 108·98 chains in length, of 1 in 2500		
Do.	15·94	” 1 in 1176
Do.	143·07	” 1 in 555
Do.	215·34	” 1 in 4000
Do.	35·92	” 1 in 303

The principal curves are—

One of 18·13 chains radius.		
Do.	119·28	”
Do.	149·10	”
Do.	74·55	”

The principal works of art are—

Sixty-four bridges and culverts.

The buildings and appendages of the Deynze station.

Thirty-four crossings of highways and roads, with double barriers.

To guard against the inundations caused by the overflow of the Lys, the road has been raised 1 ft. $7\frac{1}{2}$ in. between the distance posts No. $59\frac{1}{2}$ and 62.

SECTION FROM DEYNZE TO COURTRAY.

The section from Deynze to Courtray was opened for traffic on the 22nd of September, 1839.

The line is a single one, and is 15 miles 72 chains in length.

The sidings comprise altogether a length of 49·99 chains.

The principal slopes (*pentes*) are—

One of 117·48 chains in length, of 1 in 1666

Do.	129·61	„	1 in 1428
Do.	356·54	„	1 in 1000
Do.	45·36	„	1 in 833
Do.	20·17	„	1 in 500

The principal curves are—

One of 74·55 chains radius.

Do.	119·28	„
Do.	99·40	„
Do.	49·70	„
Do.	34·79	„

The principal works of art are—

Eighty-four bridges and culverts.

Two bridges over ordinary roads.

Sixty-five crossings of highways and roads, with double barriers.

SOUTHERN LINE.

SECTION FROM BRUSSELS TO TUBISE.

This section was opened for traffic on the 17th of May, 1840.

The execution of the works occupied two years and two months.

The line is a single one, 12 miles and 19 chains in length.

The works were contracted for—from Brussels to Forest on the 27th of February, 1839; and from Forest to Tubise on the 10th of March, 1838.

The principal curves and inclines (*rampes*) are—

1st curve, to the left, of 397·60 chains radius, and 81·64 chains in length.

2nd curve, to the right, of 24·85 chains radius, and 26·53 chains in length.

3rd curve, to the left, of 124·25 chains radius, and 53·26 chains in length.

4th curve, to the right, of 124·25 chains radius, and 21·11 chains in length.

An incline of 1 in 22222 length 132·20 chains,

„	1 in	1190	„	22·70	„
„	1 in	769	„	126·27	„
„	1 in	833	„	105·80	„
„	1 in	1660	„	93·22	„
„	1 in	970	„	62·62	„
„	1 in	384	„	257·33	„
„	1 in	3333	„	113·65	„
„	1 in	250	„	69·22	„

And a level of 16·34 chains.

The principal works of art are—

A bridge over the Senne at Droogenbosch, of 39 ft. 4½ in. span.

An iron (fixed) bridge at Loth, 32 ft. 9¼ in. span.

A bridge of masonry at Hal, 30 ft. 6 in. span.

A bridge over the Charleroy Canal, 14 ft. 1 in. span.

A bridge of masonry over the Senne at Tubise, 32 ft. 9¾ in. span.

Two bridges of 13 ft. 1½ in. span each.

Three bridges over common roads, 13 ft. 1½ in. span each.

Forty-three culverts, from 1 ft. 3½ in. to 6 ft. 6¾ in. wide.

The buildings and appendages of the Hal, Tubise, and Bogards stations.

Forty-one crossings of highways and roads, with double barriers.

SECTION FROM TUBISE TO SOIGNIES.

This section was opened for traffic on the 31st of October, 1841.

The execution of the works was commenced in November, 1839, and lasted one year and eleven months.

The line is a single one. The works were contracted for—from Tubise to Hennuyères on the 30th of October, 1839; from Hennuyères to Braine-le-Comte on the 29th of April, 1840; from Braine-le-Comte to Soignies on the 13th of May, 1840.

Its total length is 10 miles 51 chains.

The principal curves and inclines (*rampes*) are—

1st curve to the right	298·20 chains radius,	length 49·37 chains,
2nd „ left	124·25 „ „	52·27 „
3rd „ right	72·56 „ „	28·17 „
4th „ do.	72·56 „ „	10·82 „
5th „ do.	149·10 „ „	70·86 „

An incline (*rampe*), of 1 in 333, length 1·13 chains,

„	1 in 200	„	286·27	„
„	1 in 200	„	109·58	„
„	1 in 333	„	130·80	„
„	1 in 500	„	39·26	„
„	1 in 500	„	69·72	„

A slope (<i>pente</i>), of 1 in 500	„	52·42	„
„	1 in 250	„	70·11
„	1 in 500	„	33·14

The principal works of art are—

Two bridges over common roads, 13 ft. 1½ in. span each.

Several bridges over rivers, 13 ft. 1½ in. span each.

Seven culverts, 3 ft. 3½ in. wide each.

Two smaller do.

A viaduct over the railway, 29 ft. 6½ in. span.

A bridge over a common road, of two arches, 13 ft. 1½ in. span each.

The Braine-le-Comte tunnel, 16 ft. 4¾ in. wide, and 25·68 chains in length.

A bridge over the Senne, 16 ft. 4½ in. wide.

SECTION FROM SOIGNIES TO MONS.

The works of the section from Soignies to Mons were contracted for as follows :

From Soignies to Jurbise, the 18th of December, 1839. .

„ Jurbise to Bustiau, the 26th of February, 1840.

„ Bustiau to Mons, the 26th of August, 1840.

This line is a single one, 15 miles 14 chains in length.

The principal curves and gradients are—

1st curve to the left	198·80 chains radius, length	54·56 chains,
2nd „ right	149·10 „ „	108·23 „
3rd „ left	124·25 „ „	129·95 „
4th „ do.	85·27 „ „	19·24 „
5th „ do.	79·52 „ „	64·40 „
6th „ do.	74·55 „ „	60·37 „
7th „ right	41·82 „ „	40·94 „
8th „ do.	84·49 „ „	41·29 „
9th „ do.	79·52 „ „	55·50 „
10th „ do.	74·55 „ „	22·50 „

An incline (*rampe*), of 1 in 500, length 132·04 chains,

A slope (<i>pente</i>), of	1 in 250	„	330·00	„
„	1 in 400	„	27·92	„
„	1 in 250	„	203·40	„
„	1 in 250	„	180·60	„
„	1 in 275	„	37·61	„

The principal works of art are, between Soignies and Jurbise—

Two viaducts over the railway, 29 ft. 6½ in. span each.

Two bridges over common roads, 14 ft. 9 in. span each.

Eighteen culverts, from 1 ft. 11½ in. to 9 ft. 11 in. wide.

Between Jurbise and Bustiau—

Two viaducts over the railway, each 29 ft. 6½ in. span.

Two bridges over ordinary roads, each 14 ft. 9 in. span.

Three culverts, 9 ft. 11 in. wide.

Three do., 1 ft. 7½ in. and 1 ft. 11½ in. wide.

Between Bustiau and Mons—

Three bridges over ordinary roads, each 14 ft. 9 in. span.

A bridge with flood-gates over the Haine.

Two wooden bridges over the ditches in the fortifications of Mons, close to the station.

The buildings and appendages of the Mons station.

SECT. III.—*Sections in construction on the 1st of January, 1842.*

EASTERN LINE.

THE LIEGE INCLINES.⁵

To effect the descent of the railway from the table-land of La Hesbaie⁶ (from Ans) into the valley of the Meuse, the direction, after an investigation which lasted several years, and embraced the examination of a great number of projects, recognised the necessity of employing in-

⁵ The portion of the line between the stations of Ans and Liège was opened for the conveyance of goods on the 18th of April, 1842, and for that of passengers on the 1st of May; the solemn inauguration did not, however, take place until the 17th of July following.

⁶ La Hesbaie was formerly a district situated on the left bank of the Meuse, which included St. Trond, Liège, Tongres, Herstal, Waremme, Landen, Hannut, and a part of Huy. Waremme was the principal town.

clined planes, which, notwithstanding the numerous and important works they require, offer, nevertheless, the most suitable means of surmounting the difficulties which the excessive irregularities of the ground at the outskirts of the town of Liège present to the establishment of a railway.

The account of the works in the valley of the Vesdre from Liège to the Prussian frontier contains, in the description of the several lines surveyed for the inclined planes, a complete justification of the motives which induced the Government to adopt, for the entrance into Liège, the line now executed.

On leaving the Ans station, and approaching the Meuse, the line describes a curve of 116·79 chains radius, on a level, which brings it to the summit of the first inclined plane, 98·40 chains in length, overcoming a vertical height of 180 ft. 5 in. (inclination 1 in 36·1764); to this succeeds a level 16·40 chains in length, forming, opposite the Faubourg St. Marguerite, a platform on which are placed the buildings for the stationary engines. Then commences the second inclined plane, which, like the first, is 98·40 chains in length, and overcomes also a vertical height of 180 ft. 5 inches.

At the foot of this second inclined plane is the principal station of Liège, situated a few yards above the level of the Quai d'Avroy, with which it communicates by a wide street 29·82 chains in length.

On leaving the station the railway runs straight for some distance, and then, forming a curve of 49·70 chains radius, reaches the bridge of the Val-Benôit over the

Meuse, at a distance of 75·34 chains from the foot of the lower incline.

The formation of the railway in this neighbourhood was rendered very difficult by local circumstances. It was necessary to have two straight portions, each 98·40 chains in length; to cross all the communications at such a height as to allow of bridges above or below the line,—the use of ropes excluding level crossings; to balance the getting and filling so as to preserve for cultivation valuable land; and, lastly, to get rid of the material from the cuttings in a descending direction, in order to diminish as much as possible the expense of cartage.⁷

The adopted line, which fulfils as far as possible all these conditions, has required very heavy earth-works and numerous works of art.

Between Ans and the Meuse, the formation of the road, for a length of 328·02 chains, required the excavation of upwards of 731,920 cubic yards of earth and schist, the latter material having occasionally required blasting with gunpowder. The levelling for the stations, and the foundations of the buildings, have caused excavations to the amount of nearly 392,100 cubic yards.

The numerous thoroughfares existing in this populous neighbourhood rendered necessary the erection of twenty bridges in the above distance of 328·02 chains; seven of these are of large proportions, passing over the railway;

⁷ From the heights at Ans to the quays of the town of Liège, a distance of about 4 miles, the ground falls nearly 400 feet.

they have a uniform span of 27 ft. 10½ in., and are from 24 ft. to 42 ft. 9 in. in height.

The others, to the number of thirteen, placed under embankments in most places of considerable height, are of spans varying from 8 ft. 6 in. to 32 ft. 10 in., and of a maximum length of 124 ft. 8 in. between the fronts, supporting embankments of from 49 ft. 2 in. to 62 ft. 4 in. in height.

Two lines of way were at once laid down, intended, the one for ascent, and the other for descent, only. The descending track is provided throughout its whole length with guard-rails, formed of half balks of timber (see Plate 25), and at the foot of each incline there is a siding into which trains would be turned in the event of their arriving at too great a speed.

The trains descend by gravity alone, the speed being regulated by the breaks of the carriages, and when an additional check is required, by those of waggons especially constructed for the purpose, and provided with powerful breaks (waggon*s* traî*n*eaux); the time occupied in the descent is 18 minutes. The trains are drawn up the inclines by ropes which are put in motion by stationary engines, a system of which the application dates as far back as 1808, and which is consequently anterior to that of locomotives. Notwithstanding the numerous improvements which have brought locomotives into general use on roads which are nearly level, when trains have to be drawn up inclines as steep as 1 in 33, these engines lose through gravity a great portion of the power necessary to raise them-

selves; and in such circumstances stationary engines have a decided superiority over locomotives, especially on lines so important as that from Antwerp to Cologne.

Each incline is furnished with an endless rope about 6 in. in circumference. The pair of engines which works the rope of the lower incline is, according to the general custom, placed at its summit; whilst that which works the upper incline is placed at the foot of the latter.

This innovation, which is peculiar to the inclined planes of Liége, presents several advantages which merit notice. The engines being placed together, can, by a very felicitous arrangement, replace each other in case of repair, and thus render unnecessary reserve engines, which would have doubled the first outlay. Great economy of fuel results from being able to reduce the number of furnaces that would have had to be fed, had the engines been placed apart from each other. In fact, the same boilers, after having served the engines of the lower incline, continue to produce a supply of steam for the use of the engines of the upper incline.

The number of persons required to work the engines is also much reduced, and this centralization of motive power gives more unity to the service. The engineer, being stationed outside the engine-house, commands a view of both of the inclined planes and of the stokers, and is able, without leaving his place, either to start or stop the engines; he has also under his eyes a dial with a needle, the motion of which, corresponding with the progress of each ascending train, indicates its position

on the incline. This indicator is very useful in working the engines at night and during fogs.

To give the necessary signals from one end to the other of the inclined planes, tubes 1 inch diameter are made use of, running the whole length of the inclines. Each tube communicates at one end with an air-bell, partly immersed in a reservoir filled with water; at the other end is placed a whistle. On the bell being pressed down, the air, finding no other means of escape, passes through the tube and sounds the whistle placed at the other end. The air-bell is of course placed close to the monitor who has to give, and the whistle close to the one who has to receive, the signal.

By an ingenious arrangement each end of the tube can be successively placed in communication with a whistle or an air-bell, so that after giving a signal an answer can be received to give assurance of the first signal having been heard. It is by means of these signals that the engineer is informed that the trains are ready to ascend the lower incline, and afterwards that they have reached the summit of the upper incline. It is also employed to announce the arrival of the descending trains.

The rope is attached to the trains by a pair of claws, which is opened at the moment when the trains arrive at the summit of each inclined plane, so that the rope is detached without the agency of the engineer. It could be detached in the same way at any part of the inclines, in case of an accident happening during the descent.

Each ascending train being furnished with a break-waggon as in descending, in addition to the ordinary breaks of the carriages, the breaking of the rope could have no further result than occasioning a delay in the progress of the train.

As has been already mentioned, the hauling rope of each incline is an endless one. Let us fix upon some point for the purpose of following it through all its windings; for example, that at which the trains at the foot of the lower incline are attached: from this point of departure during the ascent it is carried along the middle of the road on cast iron friction sheaves placed 32 ft. 9 $\frac{3}{4}$ in. apart. It remains thus in sight as far as the point fixed upon for detaching the trains: it then descends below the road, and, passing through a tunnel, arrives at a horizontal sheave, which gives it the direction necessary for entering the grooves of the two large driving wheels. The rope makes five half-turns round each, which give it the hold necessary for drawing the trains. On leaving the driving wheels, the rope makes a half-turn round a tightening sheave attached to a tension truck placed behind the engine-house; returns thence to the railway, and having again passed round a horizontal sheave, and gone through another tunnel, reappears on the descending line, along which it is carried as on the ascent. Arrived at the foot of the incline it passes again under the rails and makes a half-turn round a sheave placed under the road, re-ascends to the level of the rails, and reaches the point whence we first set out.

The use of the tension truck just mentioned is to strain the rope sufficiently to give it a hold on the driving wheels, and to render this strain constant under all the variations of length arising from the load or atmospheric influence. To effect this the truck is drawn by a balance weight hung in a well which rises and falls according to the contraction or elongation of the rope.

The rope of the upper incline presents exactly the same arrangements.

The engine-room occupies the angle formed by the intersection of the alignments of the two inclined planes. The engines are placed in the centre, and the four large grooved driving wheels at the angles of the building. These wheels are of cast iron, 15 ft. 9 in. diameter from centre to centre of grooves. Their axles are continuations of two driving shafts, each worked by one pair of engines. By means of couplings the motion of either pair of engines can be transmitted to one of the two ropes, by throwing into gear one of the two great wheels round which it is wound. Both ropes can thus be worked with a single pair of engines; all that is necessary to effect this being, after having thrown into gear one of the driving wheels of the lower incline, to bring the train up to the intermedial platform, to throw it out of gear, and to connect the shaft with one of the driving wheels of the upper incline. This throwing out of and into gear is performed whilst the train is passing over the intermedial platform, and occasions but a slight delay, which is avoided in the ordinary working of the engines

by appropriating to the working of each incline one of the two pairs of engines. Each pair is collectively of 160-horse power, or 320-horse power in all.

The engines are low-pressure and on the marine principle, with cylinders 4 ft. 1 in. diameter, and 4 ft. 6 in. stroke. To render it more easy to start them, a small 10-horse power engine, used for supplying the reservoirs with water, works an air pump which prepares the vacuum in the condensers of the large engines.

Since the opening of the inclined planes the engines have completely fulfilled the expectations previously formed upon calculation.

They were calculated to draw a train of from twelve to fifteen carriages up each incline in 6 minutes, which is at the rate of 12 miles 34 chains per hour, whilst they have already in the same time drawn up as many as sixteen carriages.

The symmetrical arrangement of the various parts forming the *ensemble* of the stationary engines, which cover a surface of 386 square yards, and the perfect workmanship of every part, give them an air of simple grandeur, which will distinguish them from those employed for the same purposes on other railways.

The whole of the machinery for the inclined planes was manufactured at the Seraing establishment near Liège.

VAL-BENOÎT BRIDGE.

The bridge over the Meuse, which carries the railway from the Val-Benoît to the Bac-en-Pot shore, is also open for pedestrians and carriages, on payment of

a toll, which is received for the benefit of the State. This bridge is composed of five segmental arches, 65 ft. $7\frac{1}{2}$ in. span each, springing from the level of the highest water line.

The piers, which are at right angles to the longitudinal axis of the bridge, are 8 ft. $2\frac{1}{2}$ in. in thickness at top, and 9 ft. 11 in. in thickness at the base, measured above the set-off of the foundation.

Their height from the springing to the set-off is 18 ft. 4 in., and that of their footings 5 ft. $2\frac{3}{4}$ in., of which the bottom course is 16 ft. 5 in. in width.

The abutments are 50 ft. in length, not including the engaged half pier, which carries the springing of the end arches; they each contain a road-way 16 ft. $4\frac{3}{4}$ in. wide, and 16 ft. $4\frac{3}{4}$ in. in height, measured at the crown of the arch, not including 1 ft. $7\frac{1}{2}$ in., the depth of the invert, of which the centre is distant 35 ft. 3 in. from the river angles of the abutments.

The towing-paths are 8 ft. $2\frac{1}{2}$ in. below the springing line of the arches, and 13 ft. $1\frac{1}{2}$ in. in width.

The width of the bridge between the fronts of the arches is 49 ft. $2\frac{1}{2}$ inches.

The abutments, measured at the springing line, are 62 ft. 4 in. in width immediately behind the half piers, and 75 ft. 6 in. in width across the projections containing the road-ways.

The down-stream and up-stream cutwaters of the piers are of a semicircular form, and are capped by a continuous string surmounted on the outside by a curved segment 8 ft. $2\frac{1}{2}$ in. radius.

The string of the half piers is continued as an impost on the face of the abutments, and also round the inside of the arch-ways.

The large arches are 3 ft. 4 in. in thickness at the crown. They are surmounted by a horizontal cornice 1 ft. 5½ in. in height, which also runs round the outside of the abutments.

Four straight flights of steps, 9 ft. 11 in. wide, including the side walls, are placed at the extremities of the bridge; these steps lead from the level of the towing-path (where they project considerably beyond the fronts of the abutments) to that of the main cornice, and communicate with the top of the embankments of the road.

The foundations of the abutments are placed on timber platforms and piles.

The piers were built in caissons and rest upon massive platforms of timbers framed into and crossing each other, 1 ft. 7½ in. in thickness, each resting on six rows of seventeen piles each, cut to a level 5 ft. 1 in. below the lowest summer-water level, that is to say, about 7¾ in. above the level of the zero of the scale of the Meuse at the Pont des Arches at Liége.

This system of construction is unique. The timber platforms forming the bottoms of the caissons were framed on shore and launched like ships into the river. After having been towed into their proper positions they were loaded and sunk upon the pile foundations, being kept in their places by piles driven through apertures left for that purpose, provided with wells reaching to the

level of the water: these piles were afterwards built into the solid masonry of the piers.

Roads are formed under the side arches for the passage of the horses engaged in towing. The arch-ways and the space in front of the abutments are paved with stone.

At the right and left of each arch-way runs a *trottoir* with curbs of cut stone.

The main cornice already spoken of as forming a raised foot-way on the bridge is surmounted by a parapet composed of stone pilasters and cast iron balusters, placed upon stone plinths, and crowned by a capping extending also over the pilasters.

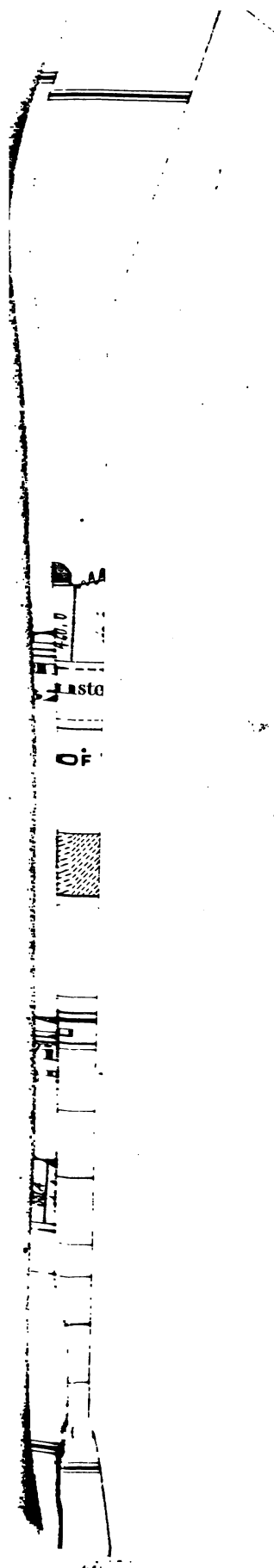
The surface of the bridge is divided into two parts in the direction of its length by a line of raised foot-way, on which is placed a railing to separate the railway from the public road.

The rails are laid on four continuous lines of stone blocks, which at the same time support the chairs and form guard-rails to prevent the trains from going off the line. (See Plate 25.) The space not occupied by the blocks is paved in brick with a fall towards the mouths of the drain-pipes, built into the vaulting for the escape of the rain water.

The abutments are surmounted on each side by a lodge, built of cut stone, intended for the toll-takers and for the police of the bridge.

The public road is paved with stone, with two side gutters which conduct the water to the drains.

The bridge is lighted by six lamps placed in the central foot-way in the line of the dividing railing.



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Each flight of steps is lighted by four lamps, placed at the upper and lower ends of the parapets.

VALLEY OF THE VESDRE (FROM LIÉGE TO THE FRONTIER
OF PRUSSIA).

The course of that part of the railway from Antwerp to Cologne comprised between Liége and the Prussian frontier was not finally determined on until the year 1839 for the section from Liége to Pepinster, and until 1840 for that from Pepinster to the frontier.

This part of the railway is of more importance than any other throughout the whole of the Belgian lines, not only on account of the difficulties of execution and the expensive nature of the works, but above all, because it is the last link of the chain which, connecting the Belgian and Prussian railways, will unite the Scheldt with the Rhine, and thus carry into effect the original objects of the law of the 1st of May, 1834.

No part of the Belgian railways offers more serious difficulties or requires more gigantic operations. In the space of less than 24 miles 68 chains, all the obstacles, all the incidents which influence the constructive arts, have been presented by the line from Liége to the Prussian frontier.

The two chains of mountains confining the valley furrowed by the river Vesdre, the existence of the chaussée following the winding course of the river, the great number of manufacturing establishments whose claims for compensation were to be avoided, or whose

acquired rights were to be respected, and other motives not less important, explain the boldness of a scheme to which all these obstacles should give way.

The extreme complexity of the elements of the plan,—the examination and the discussion of the numerous plans proposed for the route in the vicinity of Liége,—the crossing of the town of Verviers, which gave rise to long discussions,—the fixing of the point of junction between the Belgian and Prussian railways at the frontier,—and, lastly, the engineering questions which rose up en masse respecting difficulties previously unknown, but which were met with at every step upon the ground traversed by the railway,—all these circumstances were so many causes for delay in the adoption of the final plan.

The engineers, Messrs. Simons and De Ridder, had already, in 1833, prepared and presented a project for a line from Antwerp to Verviers. This project, which formed the groundwork of the law of the 1st of May, 1834, was necessarily modified after the working of the first sections opened for traffic had shown that the railway would not serve exclusively for the carriage of goods, as had been at first thought, but that it would acquire a much greater importance from transporting travellers at high speeds. The sinuous route proposed in 1833, with numerous and sharp curves, was unsuited for a passenger line, and accordingly, in 1835, fresh surveys were ordered, hastening as much as possible the proposed line from Liége to Verviers.

The point of junction between the Belgian and

Prussian railways not having been determined at this time, it was impossible to proceed with the portion comprised between Verviers and the Prussian frontier.

In a conference held in October, 1834, between the Cologne committee and the engineers of the two countries, it had however been agreed upon that whatever might be the route ultimately adopted for the Prussian railway, its junction with the Belgian line must in any case be made by the table-land of Eupen, and thence by Cornely-Munster, leaving Aix-la-Chapelle on the left.

At the request of the authorities of Aix-la-Chapelle, Messrs. Simons and De Ridder were authorized, in April, 1836, to put themselves in communication with the Prussian engineers intrusted with the surveys for the railway between Aix-la-Chapelle and the Belgian frontier. These conferences could not take place immediately, because they could not be really useful until after the surveys of the ground comprised in the extreme sections of the two lines had been entirely finished. Now it was quite necessary that they should be in as advanced a state in Prussia as in Belgium. Moreover, it was not until August, 1837, that the company formed for the construction of the Rhenish railway was formally sanctioned by His Majesty the King of Prussia. It was not therefore until after this that the surveys of the Rhenish railway between Aix-la-Chapelle and the frontier were pushed with any activity, and it was not possible before the spring of 1838 to open the conferences, and to decide positively on the point of junc-

tion, which, however, was ultimately fixed at Welkenraedt, the line from that point taking the direction of Aix-la-Chapelle.

Although for the above reasons the surveys for the part between Verviers and the frontier could proceed but slowly in the interval between the years 1835 and 1838, the final arrangements for the portion between Liège and Verviers were carried on with great activity. As early as the 5th of April, 1836, the engineer presented the plan of the part from Liège to Nessonvaux: this plan comprised two routes, one by the Val-Benoît and Chaudfontaine, the other by Grivegnée and Chaudfontaine.

This plan was approved of on the 11th of the same month, so far as concerned the part comprised between Chaudfontaine and Nessonvaux, and the engineers received authority at the same time to proceed immediately to the acquisition of the land required between the two points.

No decision could be made with regard to that part of the route included between Liège and Chaudfontaine, as much on account of the discussions which were started in favour of and against each of the two routes by Val-Benoît and Grivegnée, as on account of the indecision which still existed with regard to the course of the section from Ans to the Meuse, for which various projects were presented at the same time as that of the Government engineers.

The plans for the two proposed lines from Liège to Chaudfontaine (by the Val-Benoît and by Grivegnée)

were referred for consideration to the Corporation and the Chamber of Commerce of Liége, and on the 16th of May following a commission of inquiry was appointed, composed of Messrs. Noël, De Moor, and Masui, to ascertain which was the better route for the railway in the vicinity of this town.

This commission, after having heard the opinions of the delegates of the Corporation and of the Chamber of Commerce, and also of the principal manufacturers of the town of Liége, on the 25th of the same month made a report to the Minister of the Interior, showing the numerous objections attached to the route by Grivegnée, and concluding by giving the preference to the route by the Val-Benoît, provided that a branch line were constructed to unite the centre of Liége with the projected Guillemins station at the foot of the inclined planes.

Lastly, on the 20th of August of the same year, after having heard the partisans of both projects and having satisfied himself on all the points on which a contrariety of opinion had thrown doubts, the Minister of the Interior passed a resolution approving of the route from Liége to Chaudfontaine by the Val-Benoît and the plain of Angleur.

This resolution at the same time directed the engineers to present plans for a branch line extending from the Pont des Arches at Liége to the Guillemins station, to run along the quays of the Meuse.

The line being thus approved of from Liége to Nessonvaux, preparations might have been made for commencing the works; but the final settlement of the

business was again delayed by the uncertainty as to the route to be adopted for the inclined planes, for the situation of the Guillemins station, and for the position of the bridge over the Meuse. It would also have been injudicious to commence the works of the section from Liège to Nessonvaux so long as those between Ans and the Meuse were not in progress.

It was not until the 22nd of March, 1838, after the termination of the numerous discussions which arose out of the various objections and claims brought forward by the town of Liège, and by M. Chevron and others, that it was possible for the engineers to prepare a schedule of conditions for the execution of the works of this section by piece-work at fixed prices.

The minister of public works, in submitting this project for examination to the commission of engineers united under the direction of the inspector-general of the *ponts et chaussées*, thought it necessary to raise the question, whether it would not be preferable to adopt for the execution of these works a fixed contract instead of one by piece-work.

This commission, by its report of the 6th of June following, proposed, by a majority of three to two, to make the undertaking the subject of a contract by piece-work. The minority were in favour of a fixed contract. In order to be able to choose between the two propositions, the minister directed the preparation of a new schedule of conditions for a fixed contract.

Whilst this new schedule was in preparation, M. Vifquain, inspector of the *ponts et chaussées*, presented

his report upon the proposed branch railway to Namur, in which he pointed out the inconveniences resulting from the use of inclined planes.

This report led to a fresh inquiry as to the necessity of employing inclined planes for the descent from Ans to Liège, which was still an open question.

Desirous of having the most complete information on a subject so important before making a decision which might afterwards have been regretted, M. Nothomb, then minister of public works, in July, 1838, directed a commission of engineers to ascertain from personal survey whether it would be possible to reach the valley of the Meuse by following a longer route, in which it would be possible to overcome the difference of height between the Ans summit and the bottom of the valley by gradients of about 1 in 200, thus doing away altogether with the Liège inclined planes.

On the 20th of October following, this commission made a report which stated that in the various directions proposed or thought of for avoiding the inclined planes, it would be necessary to undertake extraordinary works, not only of great cost and almost impossible to execute, but really dangerous.

In consequence of this report the system of inclined planes and the new schedule of clauses and conditions for a fixed contract were finally approved of by a ministerial decree of the 29th of October, 1838.

This digression on the inclined planes, although foreign to the account of the Vesdre line, has been, however, necessary to explain how it happened that, although the

route from Liége to Nessonvaux was approved of on the 20th of August, 1836, it was not until 1839 that the schedule of works for this section was brought forward.

Although the attention of the minister was so particularly directed to the important question of the inclined planes, he did not neglect to hasten as much as possible the letting of the works of the Vesdre railway, and at various times recommended the greatest activity in the completion of the plans.

It was not until the 7th of April, 1839, that M. Simons brought forward a complete plan for the line from Liége to the frontier, proposing at the same time to execute at first that part only between Liége and Verviers.

It then seemed as if nothing would further delay the commencement of the first division of the Vesdre railway. However, a new invention arose which was much cried up at the time, viz., the Laignel curves,⁸ and the possibility of employing these curves gave rise to fresh delay.

The attention of the engineers was attracted by this invention, and long and warm discussions took place on the desirableness of employing this new system of curves of small radius for the line of railway in the valley of the Vesdre: it appeared that under this system the gradients might be much reduced, that there would be

⁸ M. Laignel's invention consisted in making the outer wheel run on its flange in passing round sharp curves, to effect which he proposed to substitute, when necessary, a wide plate rail for the ordinary edge rail. The elevation given to the outer rail was of course very considerable.

much fewer tunnels to cut and bridges to build, and fewer diversions of the course of the river and chaussée to be effected. Such a result, could it have been obtained, would have considerably diminished the expense of the Vesdre line.

In order that the important question of the Laignel curves might be thoroughly examined, the inspector-general of the *ponts et chaussées* proposed, by his report of the 27th of June, to put in immediate execution that portion only comprised between Liége and Chaudfontaine. The plans of this section were approved of on the 4th of July; and the adjudication, at first named for the 7th of August, took place on the 21st of the same month.

It should be observed that in the plan brought forward by M. Simons, the directing engineer, the embankment in the plain of Angleur, between the Fourchu Fossé and Chênée, was to be made with earth to be brought from the mountain, and that the commission of engineers charged with the examination of this plan thought it preferable to obtain the earth necessary for this embankment from side cuttings. The commission also thought it necessary to advise a change in the arrangement of the slopes, so as to allow the lowering of the Chênée bridge and viaduct. Nevertheless the works were tendered for as announced, but the result being considered unfavourable, the contract was not approved.

The discussion of the question of the Laignel curves, which had caused the postponement of the adjudication of the part beyond Chaudfontaine, did not promise an

early solution, for the experiments which took place had the effect of confirming in their conviction the opponents of the system, without, however, shaking that of the partisans of the contrary opinion.

In this state of things the minister of public works thought it advisable to proceed, in the most complete manner possible, to definite and conclusive trials: he therefore appointed a fresh commission, and drew up, himself, the outline of the course of experiments to be tried.

Although these trials were never completed, they sufficed to show that the new system did not offer the advantages that were expected to be derived from its adoption; for, on the 20th of September, the inspector-general proposed the adoption of M. Simons' plan as far as Pepinster, with the exception of some slight modifications in the gradients. The plans and specifications, with the schedule of conditions for the adjudication, in three lots, of the section from Liège to Pepinster, were at last approved of on the 9th of October, 1839, and the adjudication, fixed at first for the 30th of the same month, took place on the 20th of November following. The three lots together, estimated at the sum of £181,200, were contracted for at the sum of £170,360.

Summary description of the works of the first section.

From Liège to Pepinster (1st, 2nd, and 3rd lots).

The first lot of this section was divided after the adjudication into two subdivisions. First subdivision of the first lot.—Section from the Meuse to Chênée.⁹

The part of the railway comprised between the bridge over the Meuse at the Val-Benoît and the bridge over the Ourthe at Chênée forms the first subdivision of the first lot of the section from Liège to Pepinster, and has a length of 1 mile 47 chains.

The works of art of the section from the Meuse to Chênée are—

1st. A bridge over the Ourthe at Chênée, composed of three arches of 52 ft. 6 in. span, having their springings placed at the level of the highest floods.

This bridge, like that of the Val-Benoît over the Meuse, has a road-way for carriages and foot passengers: it was commenced on the 13th of May, 1840.

2nd. A viaduct of twenty-four arches, of which twelve are inside and twelve outside the zinc manufactory at Angleur; the first formed for the communications of this establishment, and the second for the escape of the flood-waters of the Ourthe.

This viaduct, which joins the bridge above mentioned, also has a road-way for carriages and foot passengers.

Its construction was commenced on the 19th of November, 1840.

⁹ This section has been lately opened.

3rd. A road-bridge opposite the Château d'Angleur, begun in May, 1842;

And, 4thly, a retaining wall on the right bank of the Fourchu Fossé.

The cost of the construction of the works of art, and of the earth-works of the section, amounts to £ 28,995. 4s.

*Second subdivision of the 1st lot, and 2nd and 3rd lots.—
Section from Chénée to Pepinster.*

The works of the second subdivision of the 1st lot, and those of the 2nd and 3rd lots, extending from the bridge of Chénée to beyond Pepinster, comprise, in addition to the embankments and cuttings, of which the sections vary according to circumstances,—

Nine tunnels and one vaulted way, making a total length of 109·34 chains.

The mountains pierced by these galleries presented great obstacles to the execution of the works, both from the unexpected presence of water and from the hardness of the rock of which they consist.

Amongst others, the Halinsart tunnel, the longest of all (in length 31·65 chains), has also been the most difficult to execute.

Fourteen bridges, from 91 ft. 10½ in. to 98 ft. 5 in. span, and generally divided into three arches of different forms and dimensions.

These bridges are built for the most part either

entirely on piles, or partly on rock and partly on piles, and four only entirely on rock.

Seventy-one road-bridges, drains, and culverts, spread over the whole length of this section.

Forty dykes and retaining walls, all rendered necessary by the diversions of the river, or by the claims of proprietors of factories.

The principal points fixed upon for the establishment of stations on the first three lots are Chênée, Chaudfontaine, and Pepinster.

The Chênée station will receive some importance from the commercial nature of the neighbouring localities, and from the arrivals by the River Ourthe.

That of Chaudfontaine will be frequented by the bathers and by the pleasure seekers of Liége, and it may be strongly presumed that it will be very productive in the summer season.

Lastly, Pepinster will receive the bathers from Spa.

The first three lots having been contracted for, the commission of engineers still remained occupied with the project from Pepinster to the frontier: this project gave rise to long discussions, not only as to the situation of the Verviers station, but on the question whether the high ground of the frontier was to be arrived at by means of a continuous incline or by an inclined plane.

Three different plans had been proposed by M. Simons, directing engineer, viz. :—

1st. A plan placing the Verviers station at the spot called *L'Harmonie*, with an embankment 9 ft. 11 in. high in the

interior of the station, and ascending by a continuous incline from the station to the Prussian frontier.

2nd. A line which would place the station at the place called Gérard-Champs, with a similar embankment at the station, and rising by a continuous incline to the frontier.

3rd. A line placing the station in the Gérard-Champs, without an embankment in the station, and rising by a continuous incline to the foot of an inclined plane, of 1 in 37, to be formed in the valley of Ruyf, and from the summit of this incline to the Prussian frontier by ordinary gradients.

On the report of the commission of engineers specially charged with the examination of the design, the last route, placing the station at Gérard-Champs, with an inclined plane at Dolhain, was approved of on the 18th of March, 1840. The specification and schedule of clauses and conditions for the adjudication of the works not being ready, M. Simons was directed to hasten their completion.

The route with the inclined plane having been adopted against the advice of M. Simons, he brought forward, in the course of the month of August, a new design, similar in every respect to that adopted on the 18th of March preceding, with the exception of the substitution of a continuous incline of 1 in 125 for the inclined plane.—See Plate 26.

This last plan was approved of on the 8th of September, 1840, without having been submitted to the council of the *ponts et chaussées*. The adjudication of the works of the section from Pepinster to the frontier took place on the 30th of the same month, and the three lots of which this section is made up, estimated at

17
24

£136,760, were let on the 16th of October for the amount of £143,800.

Soon, however, fears manifested themselves as to the difficulties, and even danger, which might attend the working of such steep gradients, when their extent was considered.

Although the works were too far advanced to return to the first plan of 18th of March, 1840, the minister of public works directed M. Vifquain to examine into the real state of the case, and by his advice appointed a commission directed to proceed to England in order to observe the effect of steep gradients on the progress of trains on the English lines, and to embody the information thus acquired in the replies to a series of questions drawn up for that purpose.

The report of this commission, which contains much valuable information on the practical working of steep gradients, set the question at rest by fully confirming the views of M. Simons.

Summary of the works of the second section, from Pepinster to the Prussian frontier, (4th, 5th, and 6th lots.)

This part of the works of the railway, which, on leaving the Pepinster district, crosses the manufacturing town of Verviers and joins the Prussian frontier, is by no means the least important division of the Vesdre line, either on account of the difficult nature of the works or the serious engineering questions to which it has given rise.

The works which compose this section consist, independently of the earth-works, embankments, and cuttings, of—

Nine tunnels of a total length of 67·09 chains.

Five bridges, of which the last, No. 19, at Dolhain, has twenty land arches, of 32 ft. 9½ in. span, and from 55 ft. 9 in. to 59 ft. in height.

Sixty-three road-bridges, drains, and culverts.

Fifty retaining walls on the banks of the river.

WESTERN LINE.

LINE FROM COURTRAY TO THE FRONTIER OF FRANCE.

The first general surveys for this line, undertaken in execution of the law of the 26th of May, 1837, were made in 1838.

It was at first intended to touch the town of Menin, and to extend the line as far as possible into Western Flanders, in which are the towns of Ypres, Poperinghe, Furnes, Nieuport, and Dixmude; but, on the one hand, the nature of the ground, considering the necessity of directing the line towards Tournay, and, on the other hand, motives of economy, and the consideration of the advantage which would accrue both to Belgium and France from taking the shortest route, induced the engineers, on leaving Courtray, to take a line which, quitting the basin of the Lys, crosses between Aelbeke and Mouscron, the lowest summit of the range which separates the above-named basin from that of the Scheldt.

This route places the highest point of the line only

78 ft. 8 in. above the Courtray station, and the distance between the two places being upwards of 5 miles, the steepest gradient necessary is less than 1 in 333.

Before reaching the French frontier, and taking the direction of Tournay, the line crosses the deep valley of Mouscron, on a heavy embankment, reaching Mouscron by a deep cutting through the hill separating the villages of Mouscron and Luigne: the Mouscron station is placed partly in this cutting.

After several conferences between Messrs. Noël and Vallée, (the engineers appointed by the French and Belgian Governments to settle the conditions of the junction of the railways of the two countries between Lille and Ghent,) it was settled by a treaty made at Ghent in November, 1838: 1st, That the definitive surveys should be made under the supposition that the French line would pass to the west of Roubaix; 2nd, That the two frontier stations of Mouscron and of Roubaix should be placed on one and the same alignment; 3rd, That the longitudinal section between Mouscron and Roubaix should present an ascending and descending slope, meeting near the frontier stream of the Espierre, so that the two stations should be placed at the two summits; 4thly, and lastly, That in the event (then considered as very improbable) of the French Government adopting a line to the east of Roubaix, this line should be united to the Belgian line, laid down as above described.

These conditions formed the basis of a preliminary plan for the line from Courtray to the frontier, presented by M. Noël on the 12th of January, 1839, and

approved by the department of public works on the 18th of February following.

In consequence of unavoidable delays the working plans, specifications, and schedule of quantities, &c., for the section from Courtray to Mouscron were not completed until January, 1840.

The project was approved of by a ministerial decree of the 22nd of February following, and the public adjudication took place on the 1st of April.

The length of the section is 7 miles 52·14 chains, as follows :

374·56 chains in straight portions.

83·43 „ in curves of 99·40 chains radius.

50·11 „ „ 86·97 „

70·17 „ „ 74·55 „

33·87 „ „ 24·85 (ending at the Mouscron and Courtray stations).

612·14 = 7 miles 52·14 chains.

The longitudinal section presents various gradients, of which the steepest does not exceed 1 in 354.

The earth-works are to the extent of 825,154 cubic yards.

The works of art under the railway itself comprise—

Twelve road-bridges and twenty-four culverts, besides forty-five drains under common roads.

The total amount of masonry in these eighty-one works of art is 10,724 cubic yards.

Amongst the subordinate works we will only mention the paving, which amounts to above 8371 square yards.

The whole of the works, estimated at £44,440, including a fixed sum of £2120, were contracted for at £37,900, or 15 per cent. under the estimate.

The arrangements for the junction of the French and Belgian railways were made by M. Debout on the part of the French, and M. Noël on the part of the Belgian Government. After several conferences between these gentlemen, which led to no result, a treaty was entered into on the 7th of January, 1841, in conformity with which the works of the junction have been executed.

The plans of the section from Mouscron to the frontier were approved of by the department of public works on the 22nd of March, 1841, and contracted for on the 15th of April following.

The line comprises two straight portions, together	chains.
making a length of	99·03
Connected by a curve of 99·40 chains radius, the length	
of whose arc is	20·81
Making a total length of	119·84

The longitudinal section presents a uniform slope of 1 in 400.

The earth-works comprise 151,297 cubic yards.

The works of art consist of two road-bridges, five culverts under the railway, and ten drains under the lateral and cross roads. The total amount of masonry contained in these works is 2288 cubic yards.

The rails are laid on this section for a double line, in accordance with the articles of the treaty of the 7th of January, 1841, which settles that a double line of way

should be at once established between the frontier stations of Mouscron and Turcoing.

The whole of the works of this section, estimated at £6800, including a fixed amount of £696, were contracted for at £5160, or about 26 per cent. below the estimates.

LINE FROM MOUSCRON TO TOURNAY.

The preliminary surveys for this line were made in 1838. The original intention of the Government was to place the Tournay station on the left bank of the Scheldt, at the Quai des Salines, thus rendering it unnecessary to cross the river, whilst, at the same time, the favourable nature of the ground on the left bank offered great advantages for the construction of the railway. The local administration of Tournay, however, were strongly opposed to this route, on the ground of its interference with valuable property in the immediate vicinity of the town, and demanded that the line should cross the Scheldt and enter the town by way of the meadows of Meir, the station being placed on the Quai du Château, on the right bank, where the line would not interfere with private rights. An additional reason for placing the station on the right bank of the river was the increased facility of effecting at some future time a junction between this town and the southern railway.

It was not without much hesitation, caused by the expensive nature of the works required for crossing the

Scheldt and for carrying the line over the Meir meadows, and not until after many conflicting projects had been examined and rejected, that the Government finally decided on adopting a line which should cross the Scheldt by a fixed bridge about a mile and a quarter below the town, and, passing over the Meir meadows, should have its terminus at the Quai du Château on the right bank of the river.

The final project for the section from Mouscron to Templeuve was approved of on the 30th of December, 1840; and the adjudication of the works took place on the 27th of January, 1841.

The project for the section from Templeuve to Tournay, by the route of the Meir meadows, was formally approved of on the 20th of January, 1841; and the works were contracted for on the 24th of February following.

The section from Mouscron to Templeuve is 7 miles 52·55 chains in length, viz. :

506·28	chains in straight portions.
45·67	„ in curves of 99·40 chains radius.
32·10	„ in one curve of 74·55 chains radius.
28·50	„ „ 24·85 (on leaving the Mouscron station).
612·55	

The longitudinal section contains various levels and inclines, of which the steepest does not exceed 1 in 330.

The earth-works amount to 543,220 cubic yards.

The works of art belonging to the line itself comprise

ten road-bridges, one of which crosses the line, and twenty-two culverts.

The remaining works of art comprise fifty-nine drains and drain-pipes. The masonry of these ninety-one works of art amounts in all to 8370 cubic yards.

The principal item of the subordinate works is a quantity of new paving, amounting to upwards of 4783 square yards.

The whole of the works, estimated at £31,000, including a fixed amount of £1480, were contracted for at £25,702. 8s., or about 17 per cent. below the estimates.

The section from Templeuve to Tournay has a length of 3 miles 53·67 chains, as follows :

225·82 chains in two straight portions.			
54·14	„	in a curve of 149·10 chains radius.	
13·71	„	„	99·40 „
293·67			

The longitudinal section, from the beginning of the section to the bridge over the Scheldt, comprises levels and inclines of which the steepest does not exceed 1 in 333: from the bridge to the foot of the ramparts the line falls at the rate of 1 in 270.

The earth-works amount to 198,698 cubic yards.

The works of art contracted for were described in the specification to consist of a bridge of two arches over the Scheldt, two road-bridges, nine culverts, and six aqueducts, exclusive of twenty-one drains to be built under the lateral and cross roads.

[As will be seen hereafter, a bridge with one arch only was substituted for the two-arched bridge over the Scheldt, and a viaduct on arches for the two large culverts intended for the escape of the water from the Meir meadows.]

The amount of masonry contained in these thirty-nine works of art, as at first intended to be executed, was about 5623 cubic yards. These works also required 15,876 cubic feet of timber, including 800 piles.

The other works worthy of mention are the retaining walls, of which there were 9328 superficial yards to be constructed; and the paving, comprising 2391 superficial yards of new work, and 2033 yards of old paving to be relaid, exclusive of 2391 superficial yards of provisional paving.

The whole of the intended works, estimated at £20,000, including a fixed amount of £960, were contracted for at £17,400, or about 13 per cent. below the estimate.

NOTE ON THE EXECUTION OF THE WORKS OF THE WESTERN LINE.

SECTION FROM COURTRAY TO MOUSCRON.

The contract for the works made on the 1st of April, 1840, was approved of on the 4th of the same month.

In consequence of the slow progress of the earth-works, especially of the Marché and Mouscron cuttings, (the earth from which had to be thrown into embankment by means of waggons on temporary rails for mean leads of 64·61 chains and 59·64 chains,) the contractor

obtained leave to execute the greater part of the embankments from side cuttings, throwing a great part of the soil from the cuttings into spoil-bank, the ground for which was acquired at his own expense.

This alteration was extremely advantageous to the Government, as the embankment formed from side cutting stood extremely well, whilst that executed with the earth from the cuttings was so bad that it was necessary to replace it with better material, as will be presently shown.

At the commencement of the year 1841 it was found that the sides of that part which had been opened of the Lauwe cutting, although on an average only 6 ft. 6 in. deep, would not stand at any slope whatever, but that driven forward by the springs which made their escape at the level of the railway, they were continually slipping, forming large cracks in the rear of the slopes which increased every day both in size and number. The ground loosened itself in successive vertical layers, and the fallen earth attained such a state of liquefaction that it was impossible to reform the slopes.

Difficulties similar in their nature, but not so great in proportion to the depths of the cuttings, having already been successfully overcome on different points of the Belgian lines, especially in the Wilmersom cutting near Tirlemont, by the construction of large drains filled with stones or fascines, it was determined to make a trial of this kind in the Lauwe cutting, which succeeded perfectly; that part of the cutting where the slopes had been reformed on this plan, in September, 1841, having stood

perfectly well throughout the winter, whilst the rest of the cutting was completely filled up with the slips, and the ground in the rear had sunk to a considerable distance.

As soon as it was ascertained, after the thaw in February, 1842, that the experimental slopes with drains, filled as above, had sustained no alteration, plans and specifications were prepared for a complete system of drainage.

The embankment formed with the earth from the part of the Lauwe cutting, opened in 1841, soon showed symptoms of failure similar to those displayed in the cutting itself, in consequence of which the contractor was forbidden to carry on the works in the manner at first intended, and it was found necessary, 1st, to throw into spoil all that part of the Lauwe cutting which remained to be opened; 2nd, to remove all the embankment which had been formed with material from this cutting; and, lastly, to reconstruct the embankment with good material taken from the environs.

Similar failures took place from the same causes in a portion of the Marché embankment, finished in 1841 with the earth from the Marché cutting; the slips reached the centre line of the embankment in many places, and in March, 1842, it was decided upon to reconstruct all the portions which had failed with material to be taken from side cuttings.

These modifications of the original plan have caused an increased expenditure to the amount of about £1160 (exclusive of the expense of the new system of drainage,

which formed no part of the contract of the 4th of April, 1840): this is covered by a corresponding diminution in the cost of the land required for the railway, and by the saving effected by constructing a great part of the masonry with Harlebeke bricks of good quality in place of bricks from Armentières (France), as at first intended.

The works relating to the laying of the additional lines of way, with the eccentrics and turn-tables in the Mouscron station, as well as the ballasting of the interior of the station, have been contracted for at £ 1117. 2s. 9½d., not including the cost of the materials.

The buildings and enclosure of this station were estimated at £ 4400, and were to be contracted for on the 8th of June of the present year, 1842.

SECTION FROM MOUSCRON TO THE FRONTIER OF FRANCE.

The contract for the works of this section, taken the 15th April, 1841, was approved of on the 29th of the same month.

The embankments on this section have failed from the same causes that affected those of the preceding section, and they must be reconstructed with material from side cuttings.

SECTION FROM MOUSCRON TO TEMPLEUVE.

The contract for the works for the construction of the road, taken on the 27th of January, 1841, was approved on the 3rd of March following.

The only important deviation from the original plan consists in throwing into spoil the greater part of the

Estampuis cutting, and executing the corresponding embankment from side cutting.

The sand for the ballasting comes from Zulte.

Two stations, or rather halting places, will be formed in this section; one at Néchin, the other at Templeuve. The cost of the erections at these stations will be very trifling.

If, however, the Tournay station should be made a principal *bureau de douane*, it would be necessary to establish *bureaux secondaires* at the stations of Néchin and Templeuve, which would then require to be completely enclosed.

SECTION FROM TEMPLEUVE TO TOURNAY.

The contract for the works, taken the 24th of February, 1841, was approved on the 5th of March following.

The specification provided that the passage of the Scheldt should be effected by means of a bridge of two arches, each 31 ft. 6 in. span, under one of which there was to be a towing-path of masonry 6 ft. 6 in. wide, thus reducing the ordinary water-way to 56 ft. 6 inches.

At the recommendation of the council of the *ponts et chaussées*, a fresh design was made, before the adjudication, for a bridge with a single arch 56 ft. 6 in. span, with a towing-path carried on brackets. This alteration made but a trifling difference in the expense, and the working drawings put in the hands of the contractor were made from the latter design.

The overflowing of the Meir meadows caused great delays in the execution of the works.

In April (1841) it was determined to construct a viaduct on arches for the length of 5 chains over the lowest part of the Meir meadows, instead of the embankment at first proposed.

By the construction of this viaduct were avoided—

1st. A very considerable amount of embankment;

2nd. A corresponding length of retaining wall to be built at the foot of the slopes;

3rd. A number of trenches in the meadows;

4th. Two bridges intended for the escape of the flood-water, which object was attained more completely by the construction of the viaduct.

It was supposed that the foundations of the piers for the arches might be of rubble or béton; but the floods preventing any accurate survey at the time, the designs were prepared for foundations of rubble-work, and the longitudinal section of the line and the designs of the works of art were modified as required.

The plans for the several alterations, having been agreed to by the contractor without any alteration in the amount of his contract, were transmitted to the department of public works on the 9th of May, 1841.

Early in June, on the retreat of the waters, the ground on the site of the viaduct was well sounded, when it was found that there was no firm bottom within 23 ft. of the surface, and it became necessary to construct the whole of the viaduct on piles from 26 ft. 3 in. to 28 ft. in length.

Note.—The whole of the line from Courtray to Tournay is now open.

SOUTHERN LINE.

SECTION FROM MONS TO QUIÉVRAIN.¹⁰

This line commences in the Rue du Rivage at Mons, crosses the fortifications by a curve 34·79 chains radius, and runs in a straight direction until it meets the Haut-Flénu Railway, 4·97 chains from the Mons and Condé Canal at the entrance of Jemmappes. From this point it takes a direction nearly parallel to the canal as far as the boundary of this commune; it then crosses the village of Quaregnon, passes close to that of Wasmuël, and runs in a straight line until opposite St. Ghislain: from this point it takes a fresh direction, crossing the village of Bossu, and, making another turn at Hainin, runs in a straight line between the chaussée from Mons to Valenciennes and the village of Thulin, and ends at the frontier near the village of Quiévrain, about 21·37 chains from the spot where the above-mentioned road crosses the French frontier.

The various straight portions, with the exception of that part of the line crossing the fortifications of Mons, are connected by curves of 149·10 chains radius.

The length of the section, as above described, is 992·88 chains.

The level of the railway is 102 ft. $4\frac{1}{2}$ in. above the level of the sea at its starting point, and 99 ft. 9 in. above the same level at its termination at the frontier.

This difference of level is overcome by gentle slopes, the steepest of which does not exceed 1 in 400.

¹⁰ Lately opened for traffic.

Between Mons and Bossu the line runs through the meadows bordering the Trouille and the Haine. The ground is almost every where composed of peat, which often becomes liquid and forms complete quagmires.

Throughout the Wasmuël and St. Ghislain marshes the railway is every where in embankment; the greatest height is 13 feet.

Between Bossu and Quiévrain the ground rises, and the railway is in cutting at four places.

The first cutting is at Bossu; length, 20·48 chains; maximum depth, 7 ft. 4 inches.

The second is opposite Hainin; length, 52·56 chains; maximum depth, 21 ft. 3 inches.

The third is between Hainin and Thulin; length, 41·74 chains; maximum depth, 12 feet.

The fourth, and last, is near Quiévrain; length, 87·96 chains; maximum depth, 21 ft. 9 inches.

The first cutting is through quicksand.

The strata of the second cutting are much distorted; after the clay is found a greasy greenish sand, clayey gravel, and potter's earth; a bed of sandstone is next passed through, after which marl is found in abundance; the potter's earth then re-appears, as well as the sand and gravel.

The third cutting is through marl and gravel; the surface is a plastic clay.

The Quiévrain cutting is in stiff wet clay.

Between Thulin and Quiévrain the line runs for the distance of 142·14 chains on embankment, 13 ft. in height throughout.

From Quiévrain to the frontier the line runs through the meadows of Honelle on embankment, about 10 ft. in height. The ground is chiefly peat.

PRINCIPAL DIVISION OF THE SECTION FROM MONS TO
QUIÉVRAIN.

This section commences at the foot of the glacis of the fortifications of Mons, and ends at the stream called *la petite Honelle*, which forms the boundary between Belgium and France.

The earth-works, the works of art, and the laying of the permanent way, were put up for adjudication on the 28th of October, 1840.

The estimate for the works amounted to £32,000. The contract, approved on the 14th November, 1840, amounted to £26,960.

The contract only included the works strictly necessary for the construction of the railway; but it was soon greatly extended in consequence of an alteration in the direction of the line between Mons and Jemmappes, the establishment of five stations, and the construction of several inclines.

The expense of these additional works amounts to £11,786. 7s. $\frac{1}{2}$ d.

The earth-works amount to 954,247 cubic yards.

The works of art are seventy-two in number, and comprise—

- 1st. A bridge of 32 ft. 10. in. span over the Honelle at Quiévrain.
- 2nd. A bridge of 27 ft. 10 $\frac{1}{2}$ in. over the Haine and the Trouille united at Jemmappes.

- 3rd. Two short tunnels, one of which is under the street of Hainin, and the other under the Bruneault chaussée, near Quiévrain.
- 4th. Two bridges, each 23 ft. span, one of which is over the Trouille, between Mons and the chaussée, from this town to Valenciennes, and the other over the Haine at Jemmappes.
- 5th. A bridge of 13 ft. 1½ in. span, over a stream in the marshes of St. Ghislain.
- 6th. A bridge of 11 ft. 6 in. span over the brook of Quaregnon.
- 7th. A bridge of 11 ft. 2 in. span over the Elouges brook, near Thulin.
- 8th. Three bridges, 9 ft. 11 in. span, one of which is in the meadows of Cuesmes, over the *Fossé des Machines*; the second under the slope of the chaussée from Mons to Tournay, near St. Ghislain; and the third over the waste channel of the Honelle, near the bridge of 32 ft. 9 in. span at Quiévrain.
- 9th. A culvert of 9 ft. 2 in. span in the meadows of Jemmappes.
- 10th. A culvert of 5 ft. 10½ in. over the Sequis brook.
- 11th. Six do. 4 „ 11 „
- 12th. Sixteen do. 3 „ 3 „
- 13th. Eight do. 2 „ 7½ „
- 14th. Eighteen do. 2 „ 1 „
- 15th. Ten drain-pipes 11½ and 15½ in. diameter.

All these works are in masonry, with the exception of the drain-pipes, which are of oak.

The greater part of the bridges are built on piles, on account of the yielding nature of the ground on which they are built.

The arches of some of the bridges are elliptical, viz., those of the following spans, 11 ft. 6 in., 23 ft., 27 ft. 10 in., and 32 ft. 9¾ inches.

The road-bridges are all constructed with flat arches.

The bridge of 23 ft. span over the Haine is on the skew, and that of 27 ft. 10½ in. has one front perpendicular to the river, which is crossed very obliquely, and the other parallel to the line of the railway: this arrangement was unavoidable, the bridge affording a passage both for the railway and a village street.

Account of the works between the Mons station and the commencement of the section from Mons to Quiévrain.

The works were contracted for, as piece-work, at about 15 per cent. below the estimates, on the 30th of March, 1841; the contract was approved of on the 30th of June following.

This contract comprises the earth-works, works of art, and laying of the permanent way, including the supply of the necessary materials. The works of art comprise—

1. A bridge in masonry over the Trouille, of one segmental arch, 23 ft. span.
2. A bridge over the principal ditch of the place, with abutments and piers of masonry supporting a timber platform, in six divisions, viz., five fixed, 16 ft. 4 in. wide from centre to centre of piers, and one moveable, 12 ft. 5 inches wide.
3. A bridge 13 ft. 1 in. span, with a timber platform resting on abutments of masonry, over the ditch of the flood dyke.
4. A culvert of masonry, 7 ft. 4 in. span, over the Fausse Trouille.
5. A culvert of masonry, 4 ft. 1 in. span, over the ditch of the covered-way.
6. The construction of retaining walls, covered with a timber platform 26 ft. 3 in. wide, in the cutting through the rampart.

7. The construction of retaining walls in the *place d'armes* of the covered-way.

The expense of the works may be estimated at £4800.

Rails, &c.—The supply of rails for the line from Mons to Quiévrain has formed the subject of three successive contracts, dated the 5th of May, 1840; the 10th of July, 1841; and the 17th of February, 1842.

The first of these contracts is for the supply of 1100 tons¹¹ of rails and chairs, at the following prices:

Rolled iron (rails), at £10. 19s. 11½d. per ton.

Cast iron (chairs), at £7. 12s. per ton.

Wrought iron (keys and spikes), at £22 per ton.

This contract amounted to the sum of £16,753. 19s. 6½d.

The second contract was for a supply of double chairs for crossings, and amounted to £127. 8s. 11½d.

The third and last contract comprised 250 tons of rails and chairs, at the following prices:

Rolled iron . . . £9 7 2½ per ton.

Cast iron 6 9 7½ „

Wrought iron 16 11 2½ „

The total amount of this contract is £3262. 9s. 11½d.

The 250 tons of rails of this last contract are made on the pattern called rails *à fausse coupe*, or *à joints à trait de Jupiter*, which has been made use of for the rails of the second line of way between Ghent and Ans, and is considered superior to that before adopted.

¹¹ The French ton is nearly equal to 19 cwt. 2 qrs. 22 lbs. English.

The whole expense, therefore, of the iron-work for the line from Mons to Quiévrain amounts to £20,143. 18s. 5½d.

Sleepers.—The sleepers for the line from Mons to Quiévrain have formed the subject of several contracts, altogether amounting to £ 6390. 15s. 2½d.

Ballasting.—The amount of ballasting required for the principal line of way, and for the sidings and inside the stations, will be about 57,678 cubic yards. The materials to be employed are pebbles, sand, scoriæ, and cinders.

The pebbles and scoriæ will be placed at the bottom of the ballasting in those parts of the embankments which are made of peat, and in the cuttings between Bossu and the frontier, where the soil is generally very wet.

Every where else sand and cinders will be employed, the latter being placed at the surface.

LINE FROM NAMUR TO CHARLEROY.

This line runs through the valley of the Sambre, being principally on the right bank of that river, and presents engineering difficulties of great magnitude, on account of the numerous works of art required and the irregular nature of the ground, which has rendered necessary a great amount of excavation and embankment.

The necessity of preserving uninterrupted the naviga-

tion of the river is a great obstacle to the rapid execution of the works, no less than thirteen bridges having to be built over the Sambre, all requiring the river to be turned during their erection.

The bridges are of a uniform design, each of three arches, 32 ft. 10 in. span, of an elliptic form, having a rise of 3 ft. 3 in. At each end of every bridge is a land arch 16 ft. 4 in. span, which serves at once for the necessary communications, and for the escape of flood-waters.

The various road-bridges over the line are 29 ft. 6 in. span, and of sufficient height to allow the locomotives to pass under them.

All the important works of the line are built of cut stone taken from the numerous and excellent quarries in the neighbourhood; but those of secondary importance are chiefly built of tooled stone.

The line is divided into four sections, viz.:

	Chains.	Contracted for
1. From Namur to Mornimont, length	719·16	1839.
2. „ Mornimont to Tamines „	495·61	April, 1840.
3. „ Tamines to Châtelineau „	369·67	„
4. „ Châtelineau to Charleroy „	285·27	Sept. 1841.
	1869·71	

There are no curves of less radius than 49·70 chains, and the gradients do not exceed 1 in 333, except one incline of 1 in 250, for the length of 41·34 chains, where the line crosses Couillet.

The line is to be laid for a single way, but the earth-works and works of art are executed for a double line.

It is expected that the line will be ready for opening in the spring of 1843.

LINE FROM CHARLEROY TO BRAINE-LE-COMTE.

This line ascends the valley of the Piéton as far as Gouy, crosses the summit ridge at Godarville, and passing the hamlet of Manage, and by Familleureux, runs from the latter place in a straight line to Braine-le-Comte.

The total length of the line is 25 miles 39·83 chains; it is divided into four sections, viz. :

- | | | |
|------------------------------------|----------------|------------------|
| 1. Charleroy to Gosselies, | contracted for | 14th May, 1841. |
| 2. Gosselies to Gouy | „ | „ |
| 3. Gouy to Familleureux | „ | 18th July, 1841. |
| 4. Familleureux to Braine-le-Comte | | 14th May, 1841. |

The gradients do not exceed 1 in 285, and none of the curves are of less radius than 49·70 chains.

The engineering difficulties are not of less magnitude than those of the line from Namur to Charleroy, the irregularity of the ground requiring heavy cutting and embankment; besides which, in some places the nature of the soil is so bad that more than ordinary precautions are necessary to keep up the slopes of the cuttings.

It is this circumstance which has led to the construction of a tunnel at Godarville 27·33 chains in length; and at Belle-tête, on account of the difficulties presented by the cutting, it is in contemplation to substitute for it either a tunnel or breast-walls of great height.

Amongst the other important works of art on the line must be mentioned—

A viaduct of nine arches, 29 ft. 6 in. span, in the valley of the Sennette.

A bridge over the Sambre.

Three bridges over the Charleroy Canal.

A bridge over the *eau d'Heure*.

Four bridges over the Piéton.

A number of short tunnels under roads, common road and other bridges, culverts, &c.

All these works are built with cut stone, rough stone, and bricks, but the latter material predominates.

The earth-works and works of art are executed for a double line, but the road will be laid for a single way only.

It is expected that the line will be ready for opening by the spring of 1843.

CHAPTER II.

CARRYING DEPARTMENT.

SECT. I.—*Carriages.*

THERE are three¹² descriptions of passenger carriages at present in use, viz., diligences (first-class), chars-à-bancs à glaces (second-class), and open and covered waggons (third-class). The diligences are divided by a narrow passage into two compartments, each holding nine persons. These carriages are lined and stuffed throughout, and are exceedingly comfortable conveyances.

There is little difference between the second and third-class carriages, except that the former are closed at the sides, as their name implies.

They each contain six rows of seats, and hold thirty-two passengers.

On the 1st of May, 1842, the number of passenger carriages was—

Berlines and diligences	100
Chars-à-bancs à glaces	} . 395
Open and covered waggons	
	495

¹² There were originally two descriptions of first-class carriages, viz., *berlines* and *diligences*, but the latter only are at present used.

This number will be progressively increased until it reaches the complement fixed by the council of the *ponts et chaussées*.

The following Table shows the actual cost of the material of the carrying department up to the 1st of May, 1842, with the probable total cost of the complement of locomotives and carriages of all descriptions considered necessary by the council of the *ponts et chaussées* for the complete working of the 348 miles of railway of which the construction has been ordered by the Government.

Description.	Number fixed by the council of the <i>ponts et chaussées</i> .	Stock existing on the 1st of May, 1842.	Re-maining to be constructed.	Price of each description of carriage.	Total cost of the stock still to be constructed.	Probable total cost of the full complement of locomotives and carriages.
				£.	£.	£. s. d.
Locomotives and tenders	180	127	53	2,000	106,000	
Diligences and berlines	160	100	60	200	12,000	
Chars-à-bancs à glaces }	600	395	205	108	22,140	
Open and covered waggons }						
Luggage waggons	100	60	40	112	4,480	
Coal do.	500	65	435	72	31,320	
Goods do.	700	388	312	68	21,200	
Wood do.	400	274	126	68	8,568	
Cattle do.	150	51	99	80	7,920	
Horse do.	40	20	20	112	2,240	
Carriage trucks	100	53	47	88	4,136	
Parcels vans	500	120	380	104	39,520	
Assistance waggons	30	14	16	68	1,088	
Coke do.	200	71	129	72	9,288	
Ballast do.	180	89	91	56	5,096	
Complement of tools in the workshops					12,000	
				Total	286,996	
From this must be deducted the value of the stock in construction on the 1st of May, 1842					9,416	
					277,580	277,580 0 0
To this must be added,						
1st. The sum expended up to the 1st of January, 1842						524,529 14 3
2nd. The sum expended from the 1st of Jan. to the 1st of May, 1842						19,811 8 2½
3rd. The sums due on the 1st of May, 1842, and since that time						2,000 0 0
Total probable cost of locomotives and carriages						823,921 2 5½

SECT. II.—*Locomotives.*

The whole of the locomotives are six-wheeled with cranked axles. The number of locomotives on the 31st of December, 1841, was one hundred and twenty-six, of which

18 had 14-inch cylinders,			
6	„	13	„
43	„	12½	„
39	„	12	„
20	„	11	„

Total 126

Of these 42 are of English, and 84 of Belgian make; the names of the makers are as follows:

ENGLISH.		BELGIAN.	
Stephenson	. . . 30	Cockerill	 69
Longridge	 10	Société du Renard	. 10
Fenton and Murray	. 1	Société St. Leonard	. 5
Sharp, Roberts, and Co.	1		—
	—		84
	42		

Thirteen engines, five with 14-inch, and eight with 13-inch cylinders, were in progress of construction at the same date. These are intended for the eastern line, which, on account of the steep gradients and the heavy traffic, requires engines of great power.

The following Table shows the limit of the load that can be drawn by a single locomotive on the maximum gradient of 1 in 200.

Diameter of cylinder in inches.	driving wheels in ft.	Pressure of steam in lbs. per sq. inch.	Speed in miles per hour.	Load in tons, including engine and tender.	
				Ordinary.	Maximum.
12½	5½	60	13 to 16	70	90 to 100
14	4½	60	13	110	140 to 150 (wheels coupled). N. B.—In snowy weather these amounts are re- duced one-half.

The average time employed in the journey from Ostend to Ans, 129 miles 67 chains, is about six hours thirteen minutes, exclusive of stoppages, which is at the rate of 20 miles 70 chains per hour.

(Note.)—It may be interesting to examine what will be the limit of the load for a single engine upon the 2½-mile incline of 1 in 125, between Dolhain and the Prussian frontier (eastern line). Assuming the resistance due to friction to be 0·004¹³ of the load, the resistance due to gravity and friction on an incline of 1 in 125 will be—

Friction	.	.	.	0·004
Gravity	.	.	.	0·008
Making together	.	.	.	0·012 of the load;

whilst on an incline of 1 in 200 we have—

Friction	.	.	.	0·004
Gravity	.	.	.	0·005
Making together only	.	.	.	0·009 of the load.

¹³ Equivalent to 9 lbs. per ton.

So that an engine under the same circumstances will draw at the same speed, on the incline of 1 in 200, $1\frac{1}{2}$ times the load it will on that of 1 in 125; and conversely the load it will draw on the latter incline will be only $\frac{2}{3}$ ths of that it will draw on the incline of 1 in 200, the speed being the same in both cases. Whence it follows that in the ascent of the Dolhain incline the weight of the trains must not, under ordinary circumstances, exceed—

For a speed of 16 miles per hour, with a locomotive of 12-inch cylinder, 50 tons.

For a speed of from 13 to 16 miles per hour, with a locomotive of 14-inch cylinder, and $4\frac{1}{2}$ -ft. wheels, 75 tons.

For a speed of from 16 to 19 miles per hour, with a locomotive of 14-inch cylinder, and 5-ft. wheels, 65 tons.

In snowy weather the effective power of the engines will be much more limited.

The following Table shows the number of miles run by locomotives from the 1st of May, 1835, to the 31st of December, 1841:

1835 (eight months)	31,297	miles	32	chains.
1836	91,838	„	51	„
1837	191,357	„	13	„
1838	403,116	„	27	„
1839	542,304	„	77	„
1840	733,879	„	47	„
1841	927,032	„	36	„

Total 2,920,826 miles 43 chains.

(N.B. The number of miles travelled by trains during this period was 2,892,980 miles 60 chains only; the remaining

27,845 miles 63 chains being run by locomotives engaged in piloting, &c.)

The total cost of the coke consumed during the year 1841 was £ 34,158. 3s. 2d., or, on an average, 9d. per mile per train.

By improved management the consumption of coke during the summer of the present year, 1842, has been brought as low as 53 lbs. 11 oz. per mile per train.

Coke ovens have been built at Mont-plaisir, Mechlin, Antwerp, Ghent, Ostend, Ans, and Hal; and the average cost of the coke produced by these seven establishments is about 1s. 2d. per cwt.

SECT. III.—*Fares, Trains, Passengers, &c.*

The fare for a first-class passenger between Ostend and Liège, a distance of 133 miles, is about ¹⁴ 12s.; for a second-class passenger 8s.; and for a third-class passenger 6s.; which are respectively at the rates of 1d., $\frac{3}{4}$ d., and $\frac{1}{2}$ d. per mile.

The following Table exhibits the total number of passengers conveyed from the 1st of May, 1835, to the 31st of December, 1841, with the corresponding receipts.

¹⁴ The fares are subject to frequent alterations.

Table of the number of travellers conveyed on the Belgian Railways from 1st of May, 1835, to the 31st of December, 1841, both inclusive.

Years.	CIVILIANS.					MILITARY.			Passengers by extra trains.	Totals.
	FIRST-CLASS.		SECOND-CLASS.	THIRD-CLASS.		Chars-à-bancs.	Waggons.	Waggons.		
	Berlines.	Diligences.	Chars-à-bancs.	Waggons.						
1835	4,534	19,100	76,847	320,958	..	..	..	..	421,439	
1836	13,131	42,752	191,358	624,066	..	..	..	..	871,307	
1837	11,782	90,803	321,413	929,714	1,072	29,793	..	..	1,384,577	
1838	17,503	215,893	604,935	1,343,354	1,611	55,007	..	..	2,238,303	
1839	2	233,264	618,296	1,049,378	1,077	50,714	..	..	1,952,731	
1840	..	243,143	656,336	1,294,934	163	3,843	900	..	2,199,319	
1841	..	210,085	719,065	1,706,724	2,395	2,395	1,475	..	2,639,744	
Totals	46,952	1,055,040	3,188,250	7,269,128	145,675		2,375	..	11,707,420	

Table showing the receipts from passenger traffic under the above heads from the 1st of May, 1835, to the 31st of December, 1841, both inclusive.

Six years 8 months. }	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
	6,262	2	2½	159,558	18	11	245,215	10	3	273,175	3	10
										4,747	13	7½
										128	0	0
										689,087	8	10

The number of passenger trains running on the several lines during the summer of the present year (1842), was as follows :

Name of line.	Between	Daily number of trains each way.
Northern line .	Brussels and Antwerp . .	4
Eastern and Western lines	{ Ostend and Liège . . . Landen and St. Trond . . Ghent and Courtray . . }	3
Southern line .	Brussels, Mons, and Quiévrain	3

In addition to these through trains there are short trains between the first-class stations.

Since their first opening in 1835, thirty-seven individuals have lost their lives on the railways, and fifty-two others have received injuries more or less serious. As will be seen by the following list, the greater part of the accidents have been caused by the imprudence of the sufferers.

Class of victims.	Accidents causing death and which may be attributed to		Accidents causing injuries of a more or less serious nature, & which may be attributed to		Total.
	the imprudence of the victims.	the railway itself.	the imprudence of the victims.	the railway itself.	
Travellers	8	1	14	6	29
Workmen and others engaged in the service of the railway . . }	17	5	15	17	54
Suicides	6	..	..	..	6
	31	6	29	23	89

SECT. IV.—*Goods traffic.*

The carriage of goods on the railways did not commence until February of the year 1838. The Table of receipts given in Chapter III. shows the rapid increase of this branch of the traffic since its first establishment.

The following are some of the rates of charge for the carriage of goods, &c.

<i>Carriage on the railway.</i>		<i>Delivery.</i>
Heavy goods	1½ <i>d.</i> per ton per mile.	7¾ <i>d.</i> per ton.
Light goods	2¼ <i>d.</i> „	9¼ <i>d.</i> „
Do. fragile	3¼ <i>d.</i> „	10¾ <i>d.</i> „
Per waggon load of four tons, 9 <i>d.</i> a mile, (loading and unloading of the waggons at the expense of the owners.)		
Carriages, four-wheeled		9¼ <i>d.</i> per mile.
Do. two-wheeled		6¼ <i>d.</i> „
Horses, three		9¼ <i>d.</i> „
Do. two		7¾ <i>d.</i> „
Do. one		6¼ <i>d.</i> „
Cattle, per waggon, five to eight beasts		7½ <i>d.</i> „
„ three or four do.		6¼ <i>d.</i> „
„ one or two do.		4¾ <i>d.</i> „

CHAPTER III.

COST, REVENUE, AND EXPENDITURE.

SECT. I.—*Cost of first establishment.*

THE total outlay of capital for the establishment of the Belgian Railways from the 1st of May, 1834, to the 1st of January, 1842, amounts to the sum of £4,162,127. 3s. 9d., which is made up of the following items:

Land, law expenses, earth-works, works of art, permanent way, stations, plantations, and general expenses	£.	s.	d.
Locomotives, carriages, &c.	3,587,563	9	10
	524,529	14	3
Total cost of first establishment	4,112,093	4	1
Maintenance of way, police, locomotive power, management, and sundries during the years 1835 and 1836, paid out of the funds voted for the construction of the railways	23,996	6	9
Balance due of advances made to the firm of Cockerill and Co., Seraing. (N.B. For locomotives, &c., to be supplied for the railways)	8,599	5	0
In hand on the first of January, 1842	16,638	7	11
Advances made to the <i>avoués</i> of the management for law expenses	800	0	0
Total of expenditure paid out of capital	£4,162,127	3	9



The annexed Table gives the details of the cost of first establishment.

The original estimates, which formed the basis of the law of the 1st of May, 1834, have been very greatly exceeded by the actual cost of the construction of the railways.

From a report presented to the Legislative Chambers in the autumn of the year 1839, it appears that up to that period the expenditure incurred in the establishment of the first lines had been nearly double the estimated amount; the excess being in the following proportions, viz.: 39 per cent. on the cost of the earth-works and works of art; 183 per cent. on that of the stations, workshops, &c.; 138 per cent. on the estimated value of the land; and 315 per cent. on the material of transport (locomotives, carriages, &c.).

This excess of the expenditure over the estimates arises partly from the fallacious nature of all estimates which are not based on previous experience, and partly from the extended views which the Government was led to adopt in consequence of the results obtained on opening the line between Brussels and Antwerp.

The unexpected amount of passenger traffic realized on this line in the course of a very short period showed the expediency of obtaining a more perfect railway and higher rates of speed than were contemplated in the enactment of the law of 1834, the main object of which was the conveyance of merchandize between the Rhine

and the ports of Antwerp and Ostend by a more rapid and economical mode of transit than previously existed.

The following enumeration of the principal deviations from the original plan brought forward in 1833 is subjoined, in justice to the eminent engineers under whose able management the railways have been constructed.

Permanent way.—The gauge has been increased from 1^m. 40^c. to 1^m. 50^c., and the middle space from 1^m. 80^c. to 2^m. 00^c. The weight of the rail was originally intended to be only 35 lbs. per lineal yard, and the chairs light in proportion. The sleepers are of larger dimensions than specified, and, to give the track more solidity, have been bedded in a ballasting of sand or gravel, which was not included in the first estimates.¹⁵

Earth-works, works of art, &c.—The increased width of the road has led to a corresponding increase in the amount of earth-works. The bridges over the railways, designed with a uniform span of 19 ft. 8 in., have been executed with spans of 23 ft., 24 ft. 7 in., and 26 ft. 3 in.; the tunnel at Tirlemont has been made 14 ft. 9 in. wide instead of 10 ft. 6 in. wide, as first intended; the large bridge over the Nèthe, at Duffel, which was intended to be of wood, has been built of masonry; that over the Scheldt, at Ghent, has been constructed for four tracks instead of two only; and the turn-bridges have been

¹⁵ The depth of the ballasting is about 0^m. 50^c., or 1 ft. 7½ inches. The cost varies from about 3s. to 5s. per cubic yard.

executed throughout in iron instead of in wood, and generally of greater spans than at first intended.

Carrying department. Stations, locomotives, carriages, &c.—In the cost of the establishment of the railways is now included the construction of booking offices and waiting rooms, warehouses, and sheds for goods; engine and carriage sheds; coke ovens, workshops, and other erections; all of which were in the year 1833 considered as belonging to the contractor for the carrying department, it being intended at that time to lease the line under Government, and consequently the estimates only included the works of construction of the railway proper.

Advantage has been taken of all the most recent improvements in the construction of the locomotives and carriages, and thus it is that the locomotives set down at first as only to cost from £800 to £1000 each, and which were to have a speed of from 10 to 15 miles an hour only, drawing a load of less than 100 tons on a level, have cost from £1520 to £1680, but are capable of drawing greater loads on inclines of 1 in 333, and even of 1 in 250, or to draw passenger trains at a speed of 24 miles per hour. The dimensions of the passenger carriages and of the trucks and waggons have been increased; the wheels have been made of wrought instead of cast iron, and the construction of the breaks, axles, and buffers, has been greatly improved as regards both safety and economy of transport.

In framing the estimates for the southern extension of

the first lines, the experience gained during the construction of the latter enabled the Government engineers to arrive at more correct conclusions respecting the probable cost; and in the spring of the year 1840 they drew up a fresh series of estimates for the completion of all the lines, which, after having been revised by the council of the *ponts et chaussées*, formed the basis of the loan of the 26th of June, 1840.

The following Tables show the difference between the actual and estimated cost of the first lines, and also the difference between the revised estimate of the year 1840 and the estimate of the present year (1842) for the total completion of the Belgian railways.

the law of the 1st of May, 1834.

[To face p. 92.]

		D, 1839.				OBSERVATIONS.
		GENERAL EXPENSES.				
N		Material of trans- port; (loco- motives, car- riages, &c.)		Surveys " and management.		
		£.	s. d.	£.	s. d.	
North line.	Me					" The annual cost of superintendence, &c., for about 70 miles of railway is as follows: One <i>ingénieur en chef directeur</i> . . . £ 600 Two <i>ingénieurs ordinaires</i> at £ 320 each 640 Six <i>conducteurs</i> at 200 each 1,200 Twenty <i>surveillants</i> at 100 each 2,000 Office expenses, printing, &c. . . . 680 Annual total £ 5,120 The average time required for the completion of a line of this length being about two years, the expense of superintendence may be taken in round numbers at about £ 150 per mile. ^b This amount also includes the cost of manage- ment, &c., for the lines from Ghent to Courtray and from Landen to St. Trond.
	Sec					
	Me					
East line.	Me					
	Lou					
	Tir	332,041	8 0	55,779	0 0	
West line.	Wa					
	Me					
	Ter					
	Ghe					
	Br					
Totals fo						
Totals fo		332,041	8 0	55,779	0 0 ^d	
Excess of						

um.

5

6

3

0

6

9

9

1000

Table showing the total estimated cost of the Belgian railways.

Name of section.		Revised estimate of 1840.			Present estimated cost.		
Railway proper.	<i>Sections open for traffic.</i>	£.	s.	d.	£.	s.	d.
	Brussels to Antwerp	303,378	2	5	303,378	2	5
	Mechlin to Ostend	633,350	4	9	633,350	4	9
	Mechlin to Ans	711,458	18	5	743,458	18	5
	Ghent to Courtray	170,923	17	7	170,923	17	7
	Landen to St. Trond	48,336	14	5	48,336	14	5
	Brussels junction line between } north and south stations	18,000	0	0	29,546	0	10
	Brussels to Mons	431,184	2	5	517,007	15	2½
	Total of sections open for traffic	2,316,632	0	0	2,446,001	13	7½
	<i>Sections in construction.</i>						
	Ans to the Prussian frontier .	728,000	0	0	1,224,000	0	0
	Braine-le-Comte to Namur .	480,148	7	2½	562,186	16	0
	Mons to Quiévrain	89,600	0	0	128,716	4	0
	Courtray to the French frontier	123,073	6	5	131,000	0	0
	Mouscron to Tournay	149,953	0	9½	111,560	0	0
	Total of sections in construction	1,570,774	14	5	2,157,463	0	0
Stations.	<i>Sections open for traffic.</i>						
	Brussels to Antwerp	144,290	11	2½	228,061	9	7½
	Mechlin to Ostend	63,529	19	2¼	84,847	15	2¼
	Mechlin to Ans	40,617	18	5	42,658	1	7¼
	Landen to St. Trond	6,823	1	7¼	6,823	1	7¼
	Ghent to Courtray	17,920	0	0	17,900	0	0
	Brussels to Quiévrain	68,220	12	0	76,731	19	2¼
	Total of sections open for traffic	341,402	2	5	457,022	7	2½
	<i>Sections in construction.</i>						
	Ans to the Prussian frontier .	40,000	0	0	132,400	0	0
	Braine-le-Comte to Namur .	31,600	0	0	75,800	0	0
	Mons to Quiévrain	12,400	0	0	22,280	0	0
	Courtray to the frontier . .	9,980	0	0	8,920	0	0
	Mouscron to Tournay	14,700	0	0	10,520	0	0
	Total of sections in construction	108,680	0	0	249,920	0	0

SUMMARY.

Name of section.	Revised estimate of 1840.			Present estimated cost.		
<i>Railway proper.</i>	£.	s.	d.	£.	s.	d.
Sections open for traffic .	2,316,632	0	0	2,446,001	13	7½
Do. in construction .	1,570,774	14	5	2,157,463	0	0
	3,887,406	14	5	4,603,464	13	7½
<i>Stations.</i>						
Sections open for traffic .	341,402	2	5	457,022	7	2½
Do. in construction .	108,680	0	0	249,920	0	0
	450,082	2	5	706,942	7	2½
Total of revised estimate of 1840	4,337,488	16	10			
Excess of present estimate over that of 1840	972,918	3	11½			
Amount of present estimate				5,310,407	0	9½
Law expenses not included in the above				6,776	11	5
Salaries of engineers, &c., prior to June, 1840				13,731	9	6
Total of present estimated cost for the completion of the several lines now in construction				5,330,915	1	8½
Estimated cost of the full complement of locomotives and carriages				823,921	2	5½
Total estimated cost of first establishment of the Belgian Railways				6,154,836	4	2½

It will be seen from these Tables that the average cost per mile of the 348 miles 71 chains of railroad now in construction will be £15,251. 19s. ¼d., not including the furnishing of the lines.

This average cost will be divided amongst the several provinces as follows:

	Cost per mile.			Length.	
	£.	s.	d.	Miles.	Chains.
Eastern Flanders	8,536	5	0	55	65
Western Flanders	9,836	12	11	51	75
Limbourg	11,072	13	3	12	32
Namur	12,855	17	6	15	41
Hainault	13,403	1	6	76	60
Brabant	14,536	1	10	70	46
Antwerp	15,795	5	9	23	21
Liège	36,938	18	6	42	51

The average cost per mile for each line will be as follows :

	£.	s.	d.
For the northern line from Brussels to Antwerp	18,012	7	10
For the eastern line from Mechlin to Liége, Verviers, and the Prussian frontier, and from Landen to St. Trond	24,578	14	9
For the western line from Mechlin to Ostend, and from Ghent to Courtray, Mouscron, and Tournay	9,231	10	2
And for the southern line from Brussels to Mons, Quiévrain, Charleroy, and Namur	13,712	1	6

That part of the eastern line between Ans and the Prussian frontier will cost on an average £ 49,093. 2s. 9d. per mile.

SECT. II.—*Capital engaged in the construction of the railways.*

The funds required for the construction of the Belgian railways have been raised, as required, by way of loan on Government securities, bearing from 3 to 5 per cent. interest. Three successive loans have been voted up to the present time; they have produced the following sums :

	£.	s.	d.
Loan of the 1st of June, 1836, at 4 per cent. .	1,094,566	11	0
„ 25th of May, 1838, at 3 „ .	1,431,121	7	0
„ 26th of June, 1840, at 5 „ .	3,280,000	0	0
Total amount of capital raised up to the 1st Jan. 1842	5,805,687	18	0

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Total brought forward . . . £ 5,805,687 18 0

From this amount must be deducted—

1. Amount expended on the construction of common roads . . .	£.	s.	d.
	320,000	0	0
2. Amount expended on buying up the grant for the canalization of the Sambre	99,600	0	0
3. Amount expended on the purchase of 4000 shares in the Rhenish railway	133,984	0	0
4. Amount of working expenses of the years 1835 and 1836, paid out of the capital as above mentioned . .	23,996	6	9
5. A portion of the loan of £3,280,000 employed to defray expenses unconnected with the railways, as stipulated by the law of the 26th June, 1840, authorizing the raising of the loan, amounting altogether to .	201,541	7	0
	779,121	13	9
	779,121	13	9
Leaving as the effective capital . . .	5,026,566	4	3

The total cost of the whole of the railways in construction is now estimated as follows:

	£.	s.	d.
Formation of the road	4,623,972	14	6½
Stations, &c.	706,942	7	2½
	5,330,915	1	8½
Locomotives and carriages	823,921	2	5½
Estimated total cost	6,154,836	4	2½
The amount of capital raised up to the present time is	5,026,566	4	3

The additional capital required for completing the whole of the railways amounts therefore to . 1,128,269 19 11½

The official returns show the amount of capital expended on the establishment of the sections that have

been opened up to the 1st of January, 1842, to be £3,023,769. 18s. 6½*d.*, of which the interest at 5 per cent., calculated respectively for the number of months that each of the sections had been open, amounted to £138,313. 9s. 6*d.*

The sales of the surplus land not required for the purposes of the railways had produced, up to the 1st of January, 1842, the sum of £601. 14s. 8*d.*

The interest of this amount, at 5 per cent., amounting to £30. 1s. 9*d.*, being deducted from the above-mentioned sum of £138,313. 9s. 6*d.*, leaves £138,283. 7s. 9*d.* as the amount to be covered by the profits arising from the working of the railways, in order to pay the interest of the capital engaged in the undertaking.

We shall presently have occasion to examine, under the head of revenue, how far this result has been obtained.

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SECT. III.—*Revenue*

The following Table shows the total amount of receipts of the railways up to the

Time during which the railways have been open.	Passenger traffic.			
	Passengers.	Luggage.	Goods.	Carriages and coaches.
	£. s. d.	£. s. d.	£. s. d.	£.
1835, 8 months.	10,759 17 11½	..	..	..
1836, 12 "	33,005 6 3½	..	..	..
1837, 12 "	55,999 10 10½	679 15 6	..	..
1838, 12 "	117,432 14 2½	4,136 17 1½	2,343 15 5½	..
1839, 12 "	145,461 15 5	5,300 11 7½	16,486 15 0½	2,743
1840, 12 "	161,878 0 3½	5,290 2 10½	39,950 9 3½	5,647
1841, 12 "	164,550 3 10	5,089 19 6½	70,236 0 0½	6,947
Total 6 years, 8 months	689,087 8 10	20,497 6 7½	129,016 19 9½	15,338
	£ 709,584 15 5½		£	

The working expenses during the

Time during which the railways have been open.	Annual expenses.				Total of receipts.
	Police and maintenance of way.	Locomotive power, repairs of carriages, &c.	Management and sundries.	Total expenditure.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£.
1835, 8 months.	2,023 7 2½	3,998 4 4½	729 6 7½	6,750 18 2½	10,759
1836, 12 "	5,305 9 11½	9,905 17 3	2,034 1 4½	17,245 8 6½	33,005
1837, 12 "	13,854 8 9	25,409 16 7½	8,330 5 2½	47,594 10 6½	56,679
1838, 12 "	25,568 10 7	68,221 2 11½	16,156 6 0½	109,945 19 6½	123,913
1839, 12 "	29,136 13 6½	77,824 13 9½	16,197 15 7½	123,159 2 11½	169,993
1840, 12 "	26,113 4 6½	81,750 19 8½	22,316 4 8	130,180 8 11½	213,406
1841, 12 "	30,397 17 6	94,784 13 11½	45,737 8 6½	170,920 0 0	249,053
Total 6 years, 8 months	132,399 12 1	361,895 8 7½	111,501 8 0½	605,796 8 9	856,810

penditure.

ry kind from the first opening of the
uary, 1842.

Ac.							
In and bonds.		Delivery of goods.		Sundries.		Annual total.	
£.	s. d.	£.	s. d.	£.	s. d.	£.	s. d.
..	..	..	..	..	..	10,759	17 11½
..	..	..	..	..	..	33,005	6 3½
..	..	..	..	..	..	56,679	6 4½
..	..	..	..	..	..	123,913	6 9
..	..	..	..	..	..	169,993	0 1
83	2 1	..	..	457	17 2½	213,406	13 8
04	11 2	1,048	3 11½	177	5 0½	249,053	6 11½
87	13 3	1,048	3 11½				
4½d.				635	2 2½	856,810	18 0½

iod were as follows:

Annual excess of receipt over expenditure.	Number of miles travelled by trains.	Average per mile per train.							
		Expenses.						Receipt.	Excess of receipt over expenditure.
		Police and maintenance of way.	Locomotive power, &c.	Management, &c.	Total.				
£. s. d.	miles. chains.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	
1,008 19 8½	31,297 32	1 3½	2 6½	5½	4 3½	6 10½	2 6½		
759 17 8½	91,838 51	1 1½	2 1½	5½	3 9	7 2½	3 5½		
1,084 15 10	191,357 13	1 5½	2 7½	10½	4 11½	5 11	11½		
1,967 7 2½	403,116 28	1 3½	3 4½	9½	5 5½	6 1½	8½		
1,833 17 1½	541,385 29	1 0½	2 10½	7½	4 6½	6 3½	1 8½		
1,226 4 8½	733,879 47	8½	2 2½	7½	3 6½	5 9½	2 3		
1,133 6 11½	900,106 20	8½	2 1½	1 0	3 9½	5 6½	1 8½		
1,014 9 3½	2,892,980 60	11	2 6	9½	4 2½	5 11	1 8½		

SECT. IV.—*Profits.*

The entire cost of the Belgian railways is now estimated at £ 6,154,836. 4s. 2½*d.*

Therefore, when the whole of the lines are opened, the annual net revenue required to cover the interest of the capital engaged at 5 per cent. will be £ 307,741. 16s. 2½*d.*

Let us examine how far this result has been attained.

The excess of the receipts over the expenditure incurred for the working of the several lines during the year 1841, amounts to £ 78,133. 6s. 11½*d.*

We have already seen that the amount of traffic necessary to pay 5 per cent. on the capital expended on the lines at present open is £ 138,283. 7s. 9*d.*, which, at the above rate of interest, represents a capital of £ 2,765,667. 14s.

The net revenue for the year 1841, therefore, is equivalent to 2·82 per cent. only on the capital.

But the great increase which has taken place in the traffic during the autumn of 1841 and the spring of 1842, has led the minister of public works to estimate the net receipts for the year 1842 at £ 320,000.

The expenditure for the same period being estimated at £ 177,600 ;

The net revenue for the year 1842 will, therefore, probably amount to £ 142,400 ;

Whilst the amount of capital which will have been employed up to the 31st of December, 1842, in the construction and establishment of the lines open for traffic up to that date, and on which the interest has

to be calculated, cannot be estimated at more than £3,200,000;

Therefore the net revenue for 1842 may be safely expected to realize 4·45 per cent. on the total cost of establishment.

Taking into consideration the great increase of traffic that is likely to result from the completion of the unfinished sections, which, uniting the Belgian to the great Continental lines, will render complete, so far as Belgium is concerned, the great chain of communication now constructing between the leading capitals of Europe, which will place Ostend, Antwerp, and Brussels within a few hours' journey of Paris, Berlin, and Vienna, there seems little reason to doubt that at no very distant period the net receipts will fully cover the interest of the capital engaged in this great national undertaking.

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